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DECORTICATION OF THE LUNG IN THE TREATMENT OF TUBERCULOUS EMPYEMA

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WHEN the American Association for Thoracic Surgery met in Detroit in May 1946, there were 3 patients with empyema of tuberculous origin in the Henry Ford Hospital. One patient had been under treatment for six years, another for three and a half years and the third for two months. In November of the same year all 3 had been discharged. This favorable turn of events was made possible by the application of the operation of pulmonary decortication to tuberculous empyema, as suggested by Gurd [1] at the meeting just mentioned.

No attempt will be made to present even a partial review of the literature on the subject of tuberculous empyema. A recent paper [2] gave references to eighty-two articles which have appeared since 1930. Most of the authors have admitted that the current plans of treatment left much to be desired. Not infrequently, when the subject has been discussed at meetings, the final emphasis has been on prevention of the condition as a complication of pneumothorax therapy. In 1938 Woodruff [3] studied 154 cases from the practices of physicians and from sanatoriums in the Saranac Lake region. The methods of treatment included repeated aspirations, irrigations with salt and dyes, oleothorax, tube drainage or thoracotomy and thoracoplasty. Forty per cent of the patients were known to be dead, and many others were not well. Almost half of the 50 patients classified as "well and working" had a residual pleural space containing air, fluid or oil. This "dead pleural space" is generally regarded as a constant hazard,[4] although in the light of the unsatisfactory state of active treatment one can understand the

From the Division of General Surgery of the Henry Ford Hospital.

Read at the fourth annual meeting of the Central Surgical Association, Chicago, Feb. 22, 1947.

1. Gurd, F. B.: Decortication in Chronic Empyema of Tuberculous Origin, J. Thoracic Surg. **16**:587, 1947.

2. Goorwitch, J.: Tuberculous Empyema Complicating Induced Pneumothorax, Am. Rev. Tuberc. **47**:394, 1943.

3. Woodruff, W.: Tuberculous Empyema, J. Thoracic Surg. **7**:420, 1938.

4. Farber, J. E.: Unexpandable Lungs, J. Thoracic Surg. **11**:424, 1942.

preference of Chandler [5] for conservative therapy (i. e., no therapy at all) in what he called "benign serous and purulent pleural effusions including tuberculous empyema."

Pulmonary decortication has been used occasionally in the management of chronic empyema of nontuberculous origin.[6] The procedure really came into its own during the recent war, when it was applied extensively and successfully to the treatment of organizing hemothorax and post-traumatic empyema.[7] However, there has been reluctance to use decortication in tuberculous empyema, as exemplified in the discussion at the 1941 meeting of the American Association for Thoracic Surgery.[8]

After Gurd's report of his first 3 cases, it appeared that tuberculosis could no longer be considered a contraindication to decortication, and I proceeded to apply it immediately to the 3 patients under my care. The reports follow.

CASE 1.—R. C., a white woman, was 29 years old when she made her first contact with the Henry Ford Hospital on Sept. 1, 1937. A mass in the neck was removed and was shown to be tuberculous. Roentgenograms of the chest had revealed a lesion of questionable activity in the base of the right lung. In March 1938 there was no change in the lesion. In April 1939 she was admitted to the hospital with the complaint of pain in the right side. The sputum contained the organisms of tuberculosis, and pneumothorax treatment was begun. Fluid accumulated in the space almost immediately, 1,200 cc. being removed on May 19. It was described as "clear, thick fluid." There is no record of a culture having been made. From that date until December 1939 the pneumothorax was maintained, with occasional aspirations of fluid (thirteen times). Acid-fast bacilli were demonstrated in the culture of fluid removed on September 20.

In December 1939 it was decided to abandon the pneumothorax and to expand the lung if possible. There was little evidence of spontaneous reexpansion, and oxygen lavage of the space was carried out on December 8 (20 liters), on December 18 (40 liters) and on December 27 (40 liters). The lung remained collapsed. Aspiration of fluid was done seventeen times from then until March 1941. The pus became definitely purulent in character, being described on June 22 as "700 cc. of thick, sanguineous pus" and on July 23 as "750 cc. of creamy pus." Oleothorax was considered in February but was decided against.

On March 30, 1941, the patient was discharged and pneumothorax treatment was continued in the outpatient department. Aspirations of fluid were carried out

5. Chandler, F. G.: Benign Serous and Purulent Pleural Effusions (Including Tuberculous Empyema): A Plea for Conservative Treatment, Brit. J. Tuberc. **36**:103, 1942.

6. Gurd, F. B.: The Surgical Treatment of the Chronic Infected Open Pneumo-Thorax, Canad. M. A. J. **11**:408, 1921.

7. Burford, T. H.; Parker, E. F., and Samson, P. C.: Early Pulmonary Decortication in the Treatment of Posttraumatic Empyema, Ann. Surg. **122**:163, 1945. Tuttle, W. M.; Langston, H. T., and Crowley, R. T.: The Treatment of Organizing Hemothorax by Pulmonary Decortication, J. Thoracic Surg. **16**:117, 1947.

8. In discussion on Singleton, A. O., and Moore, R. M.: Chronic Nontuberculous Empyema, J. Thoracic Surg. **11**:169, 1941.

eight times until Jan. 5, 1943. On that date 150 cc. of bloody purulent fluid with a putrid odor was removed. She had pain in the back and fever. Roentgenograms showed a large amount of fluid in the pleural cavity (fig. 1 *A*). She was readmitted to the hospital.

On the day of admission, 2,400 cc. of pus was removed. Six aspirations were carried out until March 4. On March 12 an intercostal tube was inserted for drainage and irrigations with isotonic solution of sodium chloride. This remained in place for a month, and a pleasing expansion of the lung was noted (fig. 1 *B*). However, there appeared to be no tendency of the visceral and parietal pleuras to become adherent, and fluid continued to form. Thoracenteses and irrigations were resumed and were continued until September 25 (fifty times). On September 29 the intercostal tube was inserted and irrigations were resumed. It was reinserted

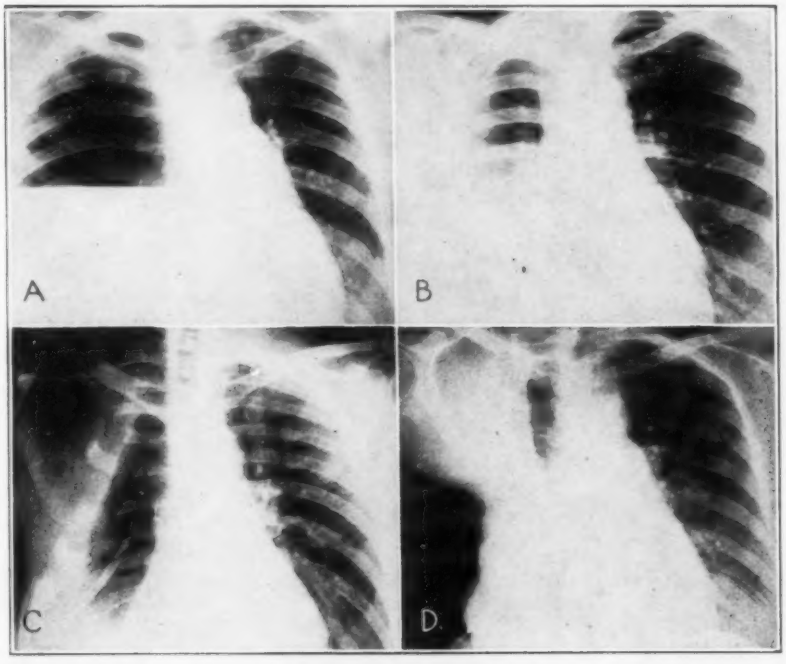

Fig. 1.—Roentgenograms in case 1. *A*, roentgenogram on Jan. 7, 1943, shows a large hydropneumothorax, with complete collapse of the lung and shift of the mediastinum. *B*, roentgenogram on April 10, 1943, after a month of intercostal drainage. The upper lobe has expanded considerably, but a small space remains. *C*, roentgenogram on June 3, 1944, after two stages of extrapleural thoracoplasty. The lung appears to fill at least the upper part of the partially collapsed chest. *D*, roentgenogram on March 8, 1946, showing final amount of bony collapse.

on November 1 and remained in place until Feb. 1, 1944. After three more aspirations, it was evident that this form of treatment was of no benefit, and since the patient wished to get home for a while, she was discharged on April 8.

At the time of her first visit to the outpatient department, the patient complained of tightness in the chest and shortness of breath. Four hundred cubic centimeters of foul fluid was aspirated. She was readmitted on April 21, 1944, for radical treatment. As a preliminary measure, an intercostal tube was inserted. Extrapleural thoracoplasty was carried out in three stages from May 12 to June 30.

As the wall of the chest collapsed, the lung was pushed in, but again there was little or no tendency for the pleural space to be obliterated and no decrease in the amount of pus which was removed through the tube (fig. 1 *C*). Resections of ribs and thoracoplasties of the Schede type were carried out on Aug. 4, 1944, Oct. 10, 1944, April 11, 1945, and Oct. 19, 1945. These procedures resulted in a collapse of the bony framework of the chest, which is illustrated in figure 1 *D*. There was a large unhealed area in the axillary region. The center and bottom of this area consisted of a surface of cortex-covered lung about the size of the palm of the hand. A few small bronchial fistulas opened intermittently. On Jan. 2, 1946, a dermatome graft was placed on the raw area; there was no take. On May 22 a

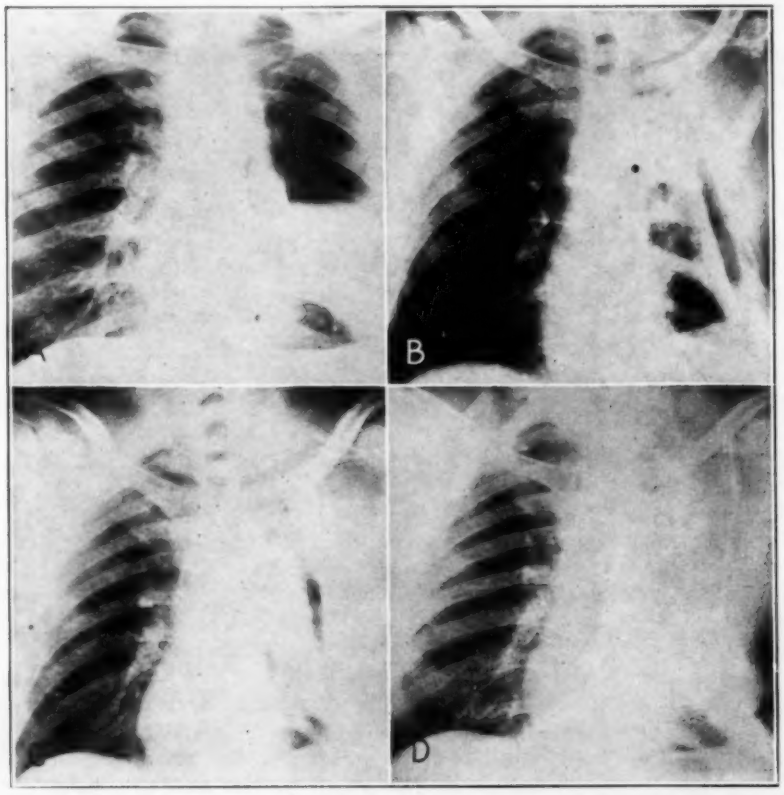

Fig. 2.—Roentgenograms in case 2. *A*, roentgenogram on June 4, 1942, showing the pleural effusion and the collapsed lung. *B*, roentgenogram on Dec. 28, 1944, shows the amount of collapse obtained from extrapleural thoracoplasty. *C*, Aug. 29, 1945. *D*, April 12, 1946. There is adequate bony collapse, but a cleft-like empyema cavity remains.

large pedicle of skin was raised from the back and flank region. One end of this was transplanted to the open area on May 8. It did not become attached to the underlying cortex at any point but lay there as a loose flap.

On May 31 I learned from Gurd's talk that it was feasible to decorticate the lung even after a long-standing empyema of tuberculous origin. On June 16 I decorticated an area just large enough to receive what was left of the somewhat shrunken pedicle graft. The graft attached itself firmly at every point of contact.

The pathologist gave the following description of the tissue removed: "Sections of the tissue show the largest piece chosen to be composed of dense fibrous connective tissue and tuberculous granulation tissue. The granulation tissue in turn is composed of numerous fairly thick-walled capillaries, epithelioid cells, giant cells and lymphocytes."

On June 17 I completed the decortication of the exposed surface of the lung, using mobilized skin about the wound to cover the fresh area. This procedure did not result in complete primary healing, but the patient was allowed to go home wearing a small dressing. At the present time, she is leading an essentially normal life and has no inclination to enter the hospital for a small skin-grafting procedure.

The treatment of this effusion complicating pneumothorax therapy involved the following: ninety-six needle aspirations, three oxygen lavages, five insertions of the intercostal drainage tube, six thoracoplasty procedures, one dermatome graft, pedicle grafting in two stages and finally decortication in two stages. It is interesting to speculate on the amount of protein which this patient lost in purulent drainage during the six years. It is recorded that 28 liters of fluid was removed by needle aspirations alone. The amount which escaped through the intercostal tube and which was soaked up in the large dressings which were changed many

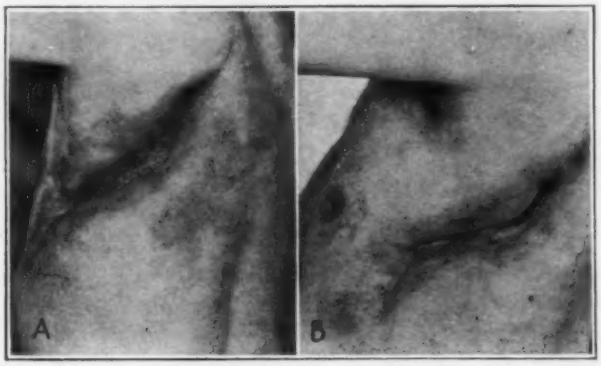

Fig. 3 (case 2).—*A*, photograph on June 13, 1946, the day before decortication; *B*, photograph on Feb. 1, 1947.

times daily for a long period is incalculable. There was, of course, considerable depletion of the plasma proteins. On June 25, 1945, the albumin was 1.88 Gm. and the globulin 2.39 Gm. per hundred cubic centimeters, a total of 4.27 Gm. During the next two months, the patient was given 16 pints (8 liters) of plasma. On November 2 the albumin was only 1.56 Gm. and the globulin 3.30 Gm. per hundred cubic centimeters. Amyloid disease was feared and later was thought to be clinically evident when a decided albuminuria developed. It is believed that this pathologic state was at least partially reversed when the chronic suppurative lesion was healed.

Case 2.—F. H., a white man aged 44 years, was admitted to the hospital on Nov. 13, 1940, with the complaint of hemoptysis. Roentgenograms showed infiltration in the upper lobe of the left lung. Acid-fast bacilli were present in the sputum. Pneumothorax was begun immediately. The sputum was sterile on Jan. 2, 1941. In March an adhesion became visible, and closed pneumolysis was performed by another surgeon, who cut through one adhesion and "three fourths of the way" through another. On April 7 fluid was noted in the pleural cavity. Thoracentesis was done on May 26, 350 cc. of dark straw-colored fluid being removed. No

tubercle bacilli could be demonstrated by culture or by inoculation of a guinea pig. On June 16 the remaining adhesion was cut. There was an immediate increase in the amount of fluid, but this was absorbed, and on August 16 no fluid was demonstrated by fluoroscopy. The patient was discharged for pneumothorax treatment in the outpatient department. On Jan. 10, 1942, he was permitted to return to light work.

On April 18, 500 cc. of straw-colored fluid was removed. Aspirations and refills of air were carried out until Jan. 16, 1943, when 800 cc. of sanguinopurulent fluid was removed. He was readmitted to the hospital on January 22. Fluid removed on this date revealed the presence of tuberculosis on culture and inoculation of a guinea pig. Six aspirations were carried out until March 10, when an intercostal tube was inserted. This was irrigated with isotonic solution of sodium chloride intermittently, suction being maintained in the intervals. On June 2 fluid removed from the tube contained the tubercle bacillus and also Staphylococcus aureus. Dilute solution of sodium hypochlorite was used for irrigating until February 1944.

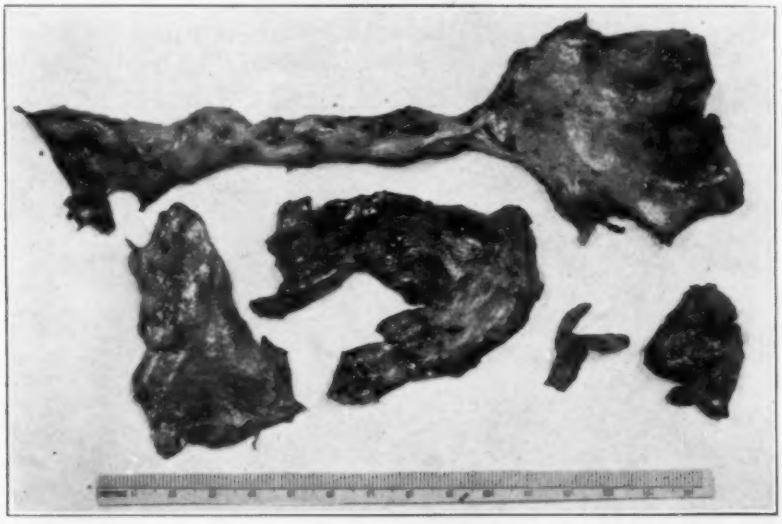

Fig. 4.—Pieces of cortex removed from the patient in case 2.

At this time it appeared that no further benefit was to be expected from this type of treatment, and extrapleural thoracoplasty was begun. The last of three stages was carried out on April 7. Intercostal drainage was maintained. These procedures transformed the empyema cavity into a cleft, with pleural and parietal surfaces in contact except when they were pushed apart by pus (fig. 2 *B*). Further rib resections of the Schede type were carried out on October 20 and October 25. It was found that the parietal cortex was from 1 to 2 cm. in thickness. At the last procedure it was noted that the hand could be passed up around the lung anteriorly as far as the upper ribs. The wound drained large amounts of green and yellow pus and was dressed twice daily. The situation was unchanged a year later (fig. 2 *C*) except that the external wound had closed somewhat, making the drainage less effective and the dressings more difficult. Another unroofing type of operation was carried out on Sept. 9, 1945. Figure 3 *A* shows the appearance of the wound eight months later. It was possible to pass one's hand up into the narrow cleft between the lung covered with cortex and the soft tissues of the axillary region. The degree of

collapse of the thoracic cage may be seen in the roentgenogram taken on April 12, 1946 (fig. 2 *D*). At this time the patient considered himself incurable of the malady of tuberculous empyema, and this feeling was shared by many others.

As soon as it was obvious that decortication was going to be of value in closing the wound in case 1, the operation was performed in this case. It was possible to remove the cortex from all the exposed pulmonary surface without doing anything more to the ribs. This cortex was probably 4 years old, yet a remarkably good plane of cleavage could be developed between it and the true visceral pleura. The membrane was removed in irregular pieces (fig. 4). The freshly decorticated lung could be expanded remarkably by positive pressure through the intratracheal tube, but no attempt was made to obtain normal expansion because of the previous collapse of the thoracic wall. Closure was obtained by mobilizing flaps of skin. The pathologic report on the cortex was as follows: "Sections of the tissue show it to

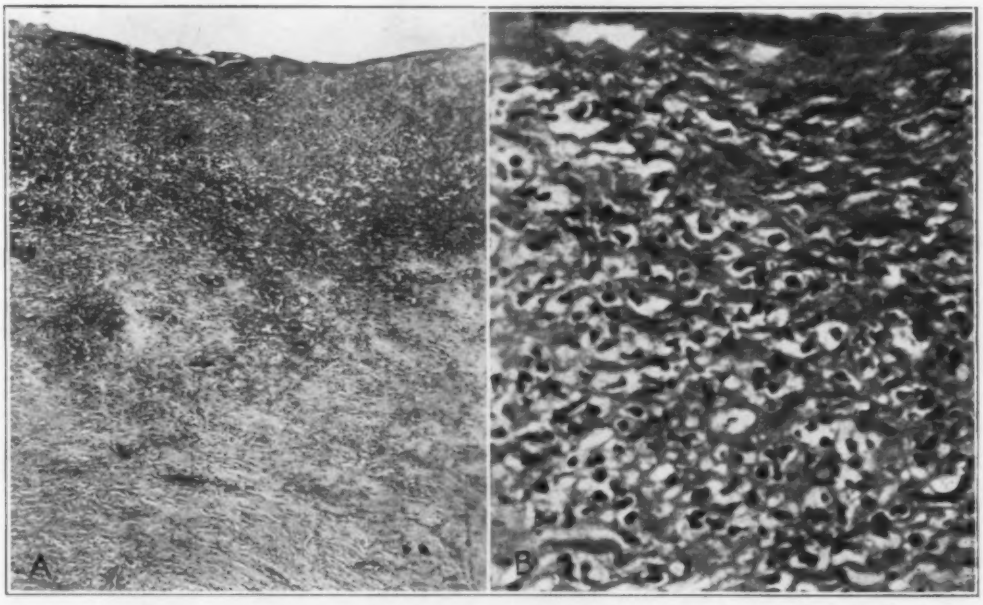

Fig. 5.—Photomicrographs of cortex (case 2). *A*, low power; *B*, high power.

be composed of fibrous connective tissue with thick collagenous bundles. The tissue is infiltrated with lymphocytes which occur in focal collections. One surface is covered by a layer of chronic granulation tissue, which in turn is covered by a small amount of fibrin, necrotic material and red blood cells. The granulation tissue contains numerous polymorphonuclear leukocytes. These extend for a short distance into the fibrous connective tissue. No tubercles are found in three sections chosen for examination" (fig. 5).

The result of this decortication was that the cavity was entirely obliterated and a linear external wound was left, which was later covered by a small dermatome graft and a few Reverdin grafts (fig. 3 *B*).

The patient was discharged from the hospital on Nov. 27, 1946. Rehabilitation from the psychologic standpoint seemed almost hopeless at first, but on a visit to the outpatient clinic recently he stated that he believed he was ready to look for a job.

The procedures used in this patient consisted of seventeen needle aspirations, one year of intercostal drainage with irrigations, extrapleural thoracoplasty in three stages and three rib resections of the Schede type. The decortication and the three minor skin-grafting procedures completed the cure.

CASE 3.—B. B. was a white woman aged 23 years. In February 1945 she had pain of a pleuritic type in the right side of the chest. An unproductive cough developed, and she felt "run down" and tired. On July 28 she had hemoptysis of half a cup of blood. She was admitted to a hospital for the treatment of municipal communicable diseases, where roentgenograms showed "scattered areas of exudative infiltration at the middle of the right lung with a one and one-half centimeter

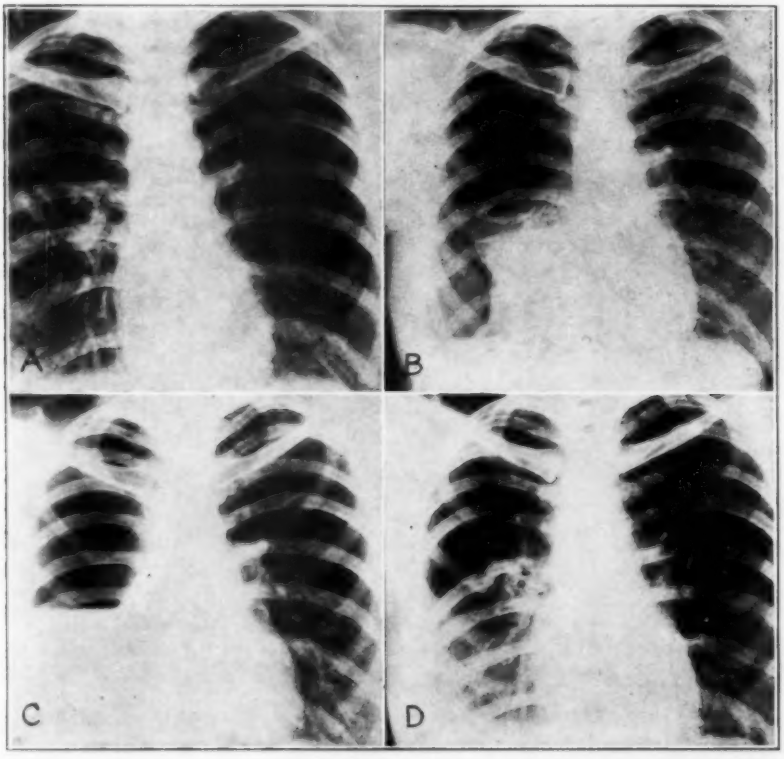

Fig. 6.—Roentgenograms in case 3. *A*, roentgenogram on Aug. 29, 1945, showing lesion in the right lung. *B*, roentgenogram on March 13, 1946, showing early fluid formation. The lung appears to be expandable. *C*, roentgenogram on May 2, 1946, shows the lung completely collapsed and encased in cortex. *D*, roentgenogram on Oct. 28, 1946, four months after decortication. Note the healed osteotomy sites on the sixth and seventh ribs on the right.

cavity just above the middle of the lung." Although the sputum did not reveal B. tuberculosis, a diagnosis of pulmonary tuberculosis, type II B., was made.

She was transferred to the Henry Ford Hospital on Aug. 24, 1945. Roentgenograms at this time were reported as showing "an area of infiltration in the right mid-lung field and also in the right lower lung field, suggesting the probability of tuberculous infiltration, with possible cavitation." Physical examination revealed numerous post-tussic rales over the involved area. Several examinations of the

sputum did not reveal bacilli. Nevertheless, it was deemed advisable to collapse the lung, and pneumothorax was established. Three months later, several posterior adhesions were noted, and closed pneumolysis was carried out on Jan. 4, 1946. Two adhesions were cut, but a third was not disturbed on account of its vascularity. On March 6 this remaining adhesion was easily cut. Eleven days later, the patient complained of pain in the chest. A roentgenogram taken on March 13 showed a fluid level in the pleural cavity (fig. 6*B*). On March 28, 200 cc. of "somewhat sanguineous fluid" was removed. No pyogenic organisms or acid-fast bacilli could be demonstrated. She had a low grade fever. Several attempts at thoracentesis were unsuccesful, although it was evident that fluid was present (fig. 6*C*). On June 13 some "cheesy, thick pus" was aspirated. Cultures were again sterile. The lung showed no tendency to expand, although no air had been put in the chest since the last pneumolysis. The stage seemed to be set for a repetition of the occurrence in cases 1 and 2. Actually, the history differed considerably.

Fig. 7.—Pieces of cortex removed from the patient in case 3.

On June 24, 1946, decortication was carried out as a primary operation. The pleural cavity was entered through the sixth interspace, the sixth and seventh ribs being transected medial to their angles. The pleural cavity contained a small amount of cloudy fluid in which floated a large ball of fibrin. The lung was thoroughly encased in a thick layer of cortex, which stripped away with ease in comparison to that in the previous 2 cases. However, in both gross and microscopic characteristics this young cortex had a remarkable resemblance to the 4 year cortex removed in case 2 (figs. 7 and 8). The pathologist reported, "Sections of the tissue show it to be composed of dense fibrous scar tissue. One surface of the fragment is covered by a layer of chronic vascular granulation tissue. There is some infiltration beneath this with round and wandering cells. In places the surface is covered with fibrin. Macrophages filled with blood pigment are seen beneath the granulation tissue in some areas. There are no characteristic tubercles."

When the decortication was complete, the lung could be expanded to fill the entire hemithorax. Mild suction was applied by intercostal catheter for two weeks.

A roentgenogram taken four months after the decortication showed a pleasing maintenance of the expansion of the lung (fig. 6 *D*).

There is no bacteriologic proof that this patient had tuberculous empyema or even pulmonary tuberculosis. She is included in the series because she plainly had pleural effusion and unexpandable lung complicating pneumothorax therapy which was being carried out because of the clinical diagnosis of tuberculosis. It is not unlikely that the pleural space would have become infected sooner or later and that this situation would have necessitated needle aspirations, intercostal drainage, extrapleural thoracoplasty and, finally, unroofing procedures.

COMMENT

It is obvious that the procedure of decortication cannot be applied indiscriminately in all cases of tuberculous empyema. The parenchymal

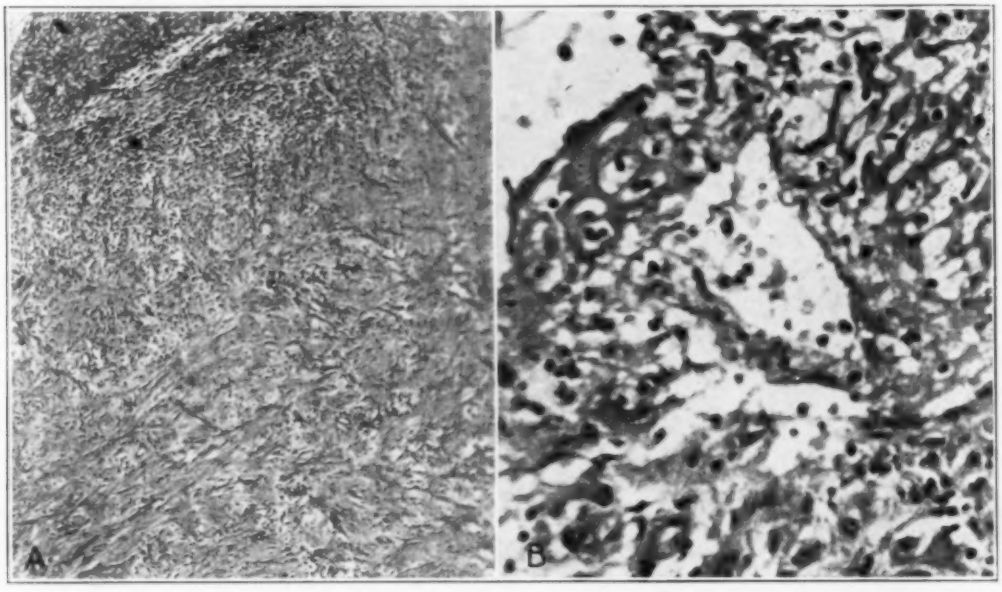

Fig. 8.—Photomicrographs in case 3. *A*, low power; *B*, high power.

lesion must not be forgotten. The fluid and cortex may actually be beneficial for a while by their immobilizing and compressive effects. However, sooner or later one must answer the question "Should the lung be reexpanded or should it have permanent collapse?" Decortication may be of value regardless of the decision. If reexpansion is the choice, decortication without thoracoplasty is the operation of choice. Obviously, if intrinsic factors in the lung prevent its expansion, some alteration of the thoracic wall may be necessary. If permanent collapse is desired, extrapleural thoracoplasty may be supplemented with decortication to achieve final obliteration of the pleural space.

SUMMARY

Pulmonary decortication has been applied, with gratifying results, to 3 patients with effusions and unexpandable lungs which complicated pneumothorax treatments. In 2 cases the procedure was used as an adjunct in the closure of large wounds in the chest which remain after extensive thoracoplastic procedures. In the third case, it was used as the primary attack on an unexpandable lung.

DISCUSSION

DR. ANTHONY R. CURRERI, Madison, Wis.: Tuberculous empyema with inexpansile lung has been an enigma confronting surgeons since the time of Hippocrates. The prolonged invalidism, the toxicity and the possible development of amyloidosis have forced surgeons to attempt various measures to control it. Unfortunately, in many instances in spite of numerous operative procedures, patients continue to have, as pointed out by Dr. Lam, residual tuberculous empyema.

The essayist has proposed decortication of the visceral pleura for this lesion and believes it will replace other modes of therapy. I wish my colleagues and I could share his optimism in this regard, but our experience leads us to conclude that decortication will have a limited but definite place in the treatment of this malady.

The first 2 patients had frank tuberculous empyema treated by tube or by open drainage of the pleural space followed by thoracoplasty, decortication and skin grafts. Both of these were discharged "just about healed." Decortication in this type of case is difficult, shocking and fraught with danger. The peel or scar is intimately attached to the visceral pleura, and in some instances the cleavage plane between the two is readily lost and the lung torn. The divided subpleural lymphatic vessels and the reactive pleuritis quickly produce an effusion, and an inexpansile lung will recur unless it is immediately expanded and kept in intimate contact with the chest wall until symphysis between the two surfaces occurs. Also, a superficial cavity may be opened and a bronchopleural fistula created.

In many cases of extensive tuberculous pulmonary disease with long-standing empyema there is fibrous tissue replacement of the pulmonary tissue; and, therefore, even with decortication the lung remains stiff and unyielding and will fail to expand adequately. Finally, the remaining small wounds or apparently healed wounds are no proof of permanent healing. Only a sufficient lapse of time will reveal whether complete healing has occurred. Our experience with unroofing and decortication of the visceral pleura in the residual empyema space has been disappointing on many occasions. Not infrequently a patient in whom an excellent result was achieved has returned at a later date presenting a tract of varying dimensions leading to the old empyema space.

The third case presented by Dr. Lam is, I believe, better suited for decortication, providing the condition of the bronchi and underlying lung is known. The presence of tuberculous bronchitis, as demonstrated by bronchoscopy, would be a contraindication to decortication and reexpansion since it may reactivate the old disease. Furthermore, reexpansion of an atelectatic lung may result in a shifting of the mediastinum and overexpansion of the intact contralateral lung. It would appear that in cases with lesions involving only the upper lobe a decortication of the lower lobe followed by thoracoplasty of the upper area would produce a selective collapse of the diseased lung and permit good function of the apparently healthy lobe. If both the upper and the lower lobes are involved in the tuberculous process, reexpansion has little value unless a complete thoracoplasty is contemplated.

The treatment of tuberculous empyema is far from simple. Our approach is briefly as follows:

1. Prevent tuberculous empyema by rapidly reexpanding the lung whenever a pleural effusion occurs with a pneumothorax. One should realize that therapeutic pneumothorax should be limited to those cases in which it is expected to be the complete and definitive treatment. The use of pneumothorax is to be depreciated in instances in which pulmonary destruction is so extensive that there is little hope for a return of the function, because these cases are usually associated with effusion and possible immobile lung.

2. Avoid, if possible, the use of open or tube drainage in tuberculous empyema and employ needle aspiration and irrigation of the pleural cavity.

3. In tuberculous empyema with inexpansible lung an examination of the bronchi and a study of the underlying lung are mandatory. In the absence of bronchitis and with involvement of the upper lobe alone, decortication and thoracoplasty of the upper area are in order.

4. If both upper and lower lobes are involved and the effusion has never shown acid-fast organisms, then pneumonectomy followed by thoracoplasty may be considered. Some risk is assumed in this procedure, for a tuberculous empyema may develop in the residual space at a later date. In this instance, decortication and rapid reexpansion followed by complete thoracoplasty may be substituted for the pneumonectomy and thoracoplasty.

5. In frank tuberculous empyema the space is cleansed by needle aspirations and irrigations and the lung reexpanded as quickly as possible. If expansion is incomplete, early thoracoplasty together with aspirations often obliterates the residual space. There remains, however, a small group of cases in which any procedure such as decortication or unroofing is justifiable in the hope of closing the cavity. It is this small group of cases which keeps the thoracic surgeon "ever so humble."

Dr. William Tuttle, Detroit: I do not share the optimism of Dr. Lam or the pessimism of Dr. Curreri. I think Dr. Lam has perhaps given you the impression that these cases are all very simple and that you can decorticate in them all. Well, you cannot. I have had considerable experience with decortication, and I feel that perhaps Dr. Langston and I are responsible for the regeneration of this operation. After all, we used it in the North African campaign for a considerable period. While we are not the ones who actually regenerated it—that honor belongs to Dr. Burford, of St. Louis—we were early in the field, and we decorticated in some 200 cases.

Decortication is not a simple procedure. All lungs do not expand after decortication. Two of Dr. Lam's patients already had had thoracoplasty, and the amount of expansion was relatively slight. I believe that those patients would have had an adherent pleura, if the visceral pleura had really been described. The last case is reported as a case of tuberculous empyema. There is no proof that it is. In the first place, I really wonder whether the patient had tuberculosis. If he had, he certainly had too much treatment for the size of the lesion. That poor patient would have done better with a simple phrenic nerve crushing. This is no criticism of Dr. Lam, because I do not think that he took care of this patient. There was a brilliant result from decortication.

Decortication can be used in certain cases. We have used it in approximately 40 cases. We are not reporting those cases because at the present time we do not know how they will turn out. There have been some very brilliant results and some very disheartening results. I do not think that at the present time any one can say how useful decortication is going to be. It is not as optimistic a picture

as Dr. Lam has given. Dr. Curreri, on the other hand, has presented the other side, and he has been extremely pessimistic. I do not share that view either. I believe that with any nonexpanding lung you will get good results with reexpansion. If one takes out the lung in cases in which thoracoplasty has been performed, the result is permanent. On the other hand, if infection enters that space, the results are not good. Our group has come to share the thought that in all these cases decortication should be attempted. After all, if the lung can be expanded this procedure should be attempted. An expanded lung is better than an unexpanded lung in the pleural space. I want to warn you that it is not all roses, as Dr. Lam has seemed to suggest, nor is it all thorns, as Dr. Curreri suggests.

DR. CONRAD R. LAM: I should like to thank Dr. Curreri and Dr. Tuttle for pointing out the limitations of decortication. My presentation would not have been complete without this further expansion of the subject. I do not agree with Dr. Curreri that the procedure is so difficult that it is almost impossible. I believe that the cortex can be removed with comparative ease in many instances, if one has patience and enough compatible blood in the operating room.

ANESTHESIA IN THORACIC SURGERY

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THERE have been tremendous advances in anesthesia for thoracic surgery in the past few years. With these improvements in anesthesia, many surgical procedures which at one time were not possible can now be done with ease. In my opinion, three of the most important technical advances are: first, the routine use of the endotracheal tube; secondly, the use of controlled respiration; and thirdly, adequate blood or fluid replacement.

In discussing anesthesia for thoracic surgery I shall limit my remarks to two main types of operations: namely, lobectomy and pneumonectomy. These patients usually differ from those in the average surgical case. They usually show prolonged toxemia of amyloid disease and require an anesthetic of low toxicity and high oxygen concentration. Their vital capacity is usually seriously decreased, and there is usually much sputum and often blood in their tracheobronchial tree.

The anesthetist is then concerned with the following problems:

1. To provide adequate oxygenation at all times.
2. To provide adequate relaxation.
3. To prevent paroxysms of coughing.
4. To prevent paradoxic respiration.
5. To assure an open airway and the means to aspirate mucus and blood from the tracheal tree.
6. To carry out and/or supervise continuous circulatory resuscitation by means of fluids such as blood, plasma or dextrose and saline solution.
7. To maintain efficient respiration under positive pressure or controlled respiration if need be.

ROUTINE PREOPERATIVE TREATMENT

A thorough routine preoperative check-up is made on each patient, consisting of the following special tests and examinations:

(*a*) Bronchoscopic examination and biopsy if indicated.
(*b*) Iodized oil U. S. P.
(*c*) Examination of sputum.

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(*d*) Complete blood count and examination of urine.
(*e*) Blood urea nitrogen test, phenolsulfonphthalein test, congo red test.
(*f*) Electrocardiogram if doubtful cardiac status.
(*g*) Postural drainage twice daily for one week preoperatively; on day of operation, one hour.
(*h*) Penicillin—aerosol and intramuscular injection.
(*i*) Breathing exercises to increase vital capacity.

Following these examinations, the patient's status as to operative risk is decided on and the chance of success evaluated.

No attempt will be made to discuss the various controversial ideas as to which anesthetic is better than another. I shall simply state that in the hands of my colleagues and myself induction with sodium pentothal followed by curare and cyclopropane, oxygen and helium has been the anesthetic of choice. Our technic is as follows:

Premedication.—The prescription for premedication is written by the anesthesia department and usually consists of morphine, ¼ grain (0.016 Gm.); atropine, 1/150 grain (0.4 mg.); or a mixture of the hydrochloride of the opium alkaloids, ⅙ grain (0.021 Gm.), and atropine, 1/150 grain (0.4 mg.).

Technic of Induction.—The patient is brought to the surgery on time and placed on the operating table only when all is in readiness. His preliminary medication, usually consisting of a mixture of hydrochloride of the opium alkaloids ⅓ grain, and atropine 1/150 grain, has been given one hour earlier.

Pentothal sodium in a 2.5 per cent solution, is given slowly intravenously until the patient stops counting or talking. Note is made of the number of cubic centimeters necessary to produce this effect and the same number of cubic centimeters is given in addition. For example, if it requires 6 cc. of pentothal to cause the patient to stop counting, then an additional 6 cc. is given. Saline solution is allowed to flow through the system for one minute and then 3 cc. of d-tubocurarine is given. One or two minutes are allowed to pass and then intubation under direct vision is done and a woven catheter with an inflatable cuff is inserted into the trachea. The cuff is inflated, and the catheter is immediately connected to a to and fro absorber. The insult to the trachea produced by the catheter will often cause the patient to cough or breathe deeply. The bag has been previously filled with a 50 per cent mixture of cyclopropane and oxygen and either active or passive respiration is then carried on. The percentage of cyclopropane is then rapidly reduced to an average of 18 to 20 per cent.

The foregoing procedure must be done rapidly, and actually takes less time to do than to describe in detail. The necessity for speed and readiness of tracheal tube, etc., is apparent, I am sure. Because of the absolute paralysis of the patient and failure of respiration in a patient

who does not stand anoxia well, no time must be lost in resuming respiration, actively or passively.

ANESTHESIA

We like to use a to and fro system and at the present time are using a Foregger metric machine. As previously stated, we use an 18 to 20 per cent mixture of cyclopropane for analgesia. All anesthesia is done by controlled respiration.

As is well known, there are three mechanisms by which controlled respiration is made possible:

1. *By the Use of Anesthetic Agents Which Depress the Medullary Center.*—Cyclopropane in a concentration of 30 to 40 per cent will do this. Morphine and pentothal will also cause depression.[1] Here one is using all three, and since none of these are irritants they do not activate any reflexes to stimulate respiration; the result is depression. The high oxygen concentration in use with cyclopropane prevents the chemoreceptor reflexes of the carotid and aortic bodies from being aroused owing to anoxemia—so finally respiration stops.

2. *By Hyperventilation.*—By hyperventilation one can "blow off," so to speak, enough carbon dioxide and raise the arterial oxygen to such a level that the respiratory center is inactive. By hyperventilating the patient and giving him anesthetic gases at the same time the center is further depressed, and carbon dioxide must be built to an even higher level than normal before respiration is resumed.

3. *By the Use of Curare or d-Tubo-Curarine.*—The myoneural junction can be blocked with these drugs, paralysis of all skeletal muscle being produced, including respiratory muscles. The respiratory muscles are the last to be paralyzed and the first to return to normal. Thus, this is an ideal agent, which allows one to maintain a much lighter plane of anesthesia than would be otherwise possible.

We prefer the latter method of controlling respiration over the other two methods, and have been using it in our work for three years. The depth of anesthesia is simply maintained below the cough or pain reflex. Cyclopropane is thus used to relieve pain and muscular relaxation, and quiet breathing is achieved by curare and controlled respiration.

We have noted in our cases that very little, if any, anesthesia is needed during the last hour of operation. This fact is not readily appreciated, and I think many beginners make the mistake of giving too much anesthesia rather than too little. Our patients are awake at

1. Dripps, A. D., and Dumke, P. R.: Effects of Narcotics on Balance Between Central and Chemoreceptors Control of Respiration, J. Pharmacol. & Exper. Therap. **77**:290-299, 1943.

the *end* of the operation and are able to cough, thus protecting themselves from possible aspiration of mucus, blood, etc.

Position on Table.—We think position on the table is very important. Dr. George Curtis and I have worked out a technic in which nearly all operations are done with the patient flat on his back. This position is best for the patient even though it is slightly disadvantageous for the surgeon. If surgeons pause to consider the advantages to the patient, I believe more of them will use the supine position.

Advantages of Supine Position:

1. If the patient is supine the mediastinum tends to remain in the midline. Positive pressure therefore need be minimal.

2. Spillage of sputum into the unaffected side is minimal. In fact, Overholt [2] has performed major thoracic surgery under local anesthesia and has the patient on the operating table with the diseased side dependent.

The lateral position with side to be operated on up has the following disadvantages to the patient:

1. The mediastinum deviates markedly to the normal side because the lung on the side operated on tends to collapse, and air rushes into the pleural space because this opening is much larger than the tracheal opening and air intake is greater.

2. If the patient lies with the side operated on uppermost, the weight of the heart and lung, especially if the left side is up, will compress the good lung—requiring more positive pressure to keep it inflated.

Blood Volume.—The third of our important "musts" in anesthesia in thoracic surgery is "blood volume." The first was oxygenation by controlled respirations; the second was position on the table, and now I shall discuss replacing adequately lost blood.

Fluid balance and maintenance of blood volume cannot be overstressed. It will be remembered that in doing lobectomy and pneumonectomy, considerable loss of blood is an invariable accompaniment of these procedures. It is reliably estimated that between 1,000 and 2,000 cc. of blood is lost in the average operation. This amount must be replaced if one is to treat the patient adequately. I believe our colleagues in the army will agree and have proved that if a large amount of blood is lost suddenly, owing to hemorrhage, an equal amount must be replaced quickly to keep the circulating volume up to normal.

We therefore start our transfusions—one in the arm and one in the leg—at the time of the first incision. We allow the transfused

2. Overholt, R. H.; Wilson, N. J., and Lauger, I.: Further Experiences in Resection of Pulmonary Tuberculosis, paper read at the meeting of the American Association for Thoracic Surgery, Detroit, May 31, 1946.

blood to drip slowly, speeding up or slowing down as the occasion demands. We find it much safer to have the needle in place and a slow steady drip of blood or saline solution than to try to find a vein in a collapsed vascular system. It is much easier to maintain a given blood volume than to try and build up a vascular system that has collapsed. It takes very little time, only a matter of a few minutes, to damage the cardiovascular system dangerously, with ensuing shock and death.

TABLE 1.—*Age Incidence in Surgical Thoracic Conditions*

1942 to 1944	Males and Females	
Age	Number	Per Cent
0- 9	3	5.2
10-19	7	12.4
20-29	19	34.7
30-39	6	10.6
40-49	8	14.2
50-59	8	14.2
60-up	5	8.7
Total	56	100.0

1944 to 1946			
Age	Number	Male	Female
0- 9	0	0	0
10-19	12	7	5
20-29	26	9	17
30-39	23	13	10
40-49	12	7	5
50-59	15	9	6
60-69	5	3	2
70-79	1	1	..
Totals	94	49	45
Total number of cases in 4 years	150		

TABLE 2.—*Time of Operation*

	Range	1 hour 25 minutes to 4 hours 55 minutes
	Average	2 hours 34 minutes
Ak	Average	2 hours 30 minutes
Ae	Average	3 hours 50 minutes

STATISTICAL ANALYSIS OF CASES AS TO VARIOUS FACTORS

In analyzing our cases as to age groups we find the greatest number of cases to be in the 20 to 29 year group, followed closely by the 30 to 39 year group, as shown in the following tables.

The time of operation is shown in table 2. This time factor has remained rather constant in the last four years.

The type of operation performed is indicated in table 3.

Lobectomy of the left lower lobe predominated in both groups; the next most common operation was lobectomy of the right middle and the right lower lobe. There is also noted a marked increase in cases of pneumonectomy on the left side.

The indications for operation are shown in table 4.

In the 1944 to 1946 group the abscess of the lungs, of which there were only one or two cases, were classified with bronchiectasis.

TABLE 3.—*Type of Operation*

Types	1942 to 1944	1944 to 1946
1. Lobectomy, left upper	2	1
2. Lobectomy, left lower	23	38
3. Lobectomy, right lower and middle	2	4
4. Lobectomy, right lower	5	15
5. Lobectomy, right middle	3	18
6. Lobectomy, right upper	1	0
7. Lobectomy, right upper and middle	..	1
8. Pneumonectomy, right	9	3
9. Pneumonectomy, left	3	12
10. Lingulectomy	..	2
Totals	48	94

TABLE 4.—*Indications for Operation*

1942-1944		1944-1946	Male	Female	Total
Bronchiectasis	36	Bronchiectasis	38	37	75
Abscess of lungs	10	Carcinoma	14	5	19
Carcinoma	2	Totals	52	42	94
Total	48				

TABLE 5.—*Complications*

1. Abdominal distention	1
2. Empyema	3
3. Empyema, bronchopleural fistula	1
4. Pleuritis	1
5. Hemothorax	2
6. Postoperative atelectasis	3
7. Pleural effusion with atelectasis	2
8. Pleural effusion	2
9. Bronchopneumonia	1
10. Shock—15 hours	2
11. Subcutaneous emphysema	1
12. Pulmonary embolism	2
13. Phlebitis	1
Total	22

TABLE 6.—*Deaths*

1942-1944		1944-1946	
Total number of cases	59	Total number of cases	94
Total number of deaths	13	Total number of deaths	13
Total number recovered	46	Death due to anesthesia	1
Deaths due to anesthesia	4 or 6.7%	Death due to surgery	0
Deaths due to surgery	9 or 13%		

Note the tremendous increase in carcinoma. We doubled our number of operations, but the incidence of carcinoma increased nine times over the 1942 to 1944 group.

The complications encountered are listed in table 5. There were 22 complications in the last 94 operative cases, none of which proved serious.

Table 6 contains data on deaths following operation.

In the 1942 to 1944 group there were four deaths due to anesthesia —directly or indirectly—thus making an anesthetic mortality of 6.7 per cent.

Deaths due to surgery were nine, or an operative mortality of 13 per cent.

In our 1944 to 1946 group there were thirteen deaths. Of these, only one could be attributed to anesthesia.

SUMMARY

A review of the cases of lobectomy and pneumonectomy done in the University Hospital at Columbus for the years 1942 to 1946 has been presented.

The technic of intubation using pentothal 2.5 per cent for analgesia and d-tubo-curarine for relaxation has been described.

The three most important principles in anesthesia in thoracic surgery have been discussed and these are:

(1) Adequate oxygenation by controlled respiration.

(2) Physiologic positioning which would be supine or flat on the back because of (*a*) least amount of mediastinal shift; (*b*) minimum amount of positive pressure for effective respiration; (*c*) minimal flooding of infected sputum to opposite lung.

(3) Adequate replacement of blood volume, preferably with blood, secondly plasm, and lastly with crystalloids.

Tracheal toilet is carefully performed at the end of each operation to assure an open airway and freedom from blood, mucus or plugs of various kinds.

A statistical study is given of cases as to age, pathologic process involved, type of operation, per cent of complications and the number and causes of deaths.

We have improved our mortality rate by the foregoing methods of anesthesia by almost 100 per cent.

TRANSGASTRIC REMOVAL OF LARGE SOLID BODIES IMPACTED IN THE LOWER PART OF THE ESOPHAGUS

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AND
W. F. MOLT, M.D.
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A PATIENT with a large solid object impacted in the lower part of his esophagus is in great danger of death. Extraction through the mouth with forceps and esophagoscope is perilous and often impossible. This is because manipulation of the object through a tube of great length and with a diameter of only 1 cm. is extremely difficult. Forceful, blind traction on it is likely to rupture the esophagus. The danger of this accident is great when the object has sharp points or has caused pressure necrosis of the esophagus. Transpleural removal has been done and also digital removal through the stomach, but there are serious objections to both operations.

These considerations made us think it worth while to report the following method which we have used with success in 1 case. We can find but one report of the use of a similar method. This is by Boone and Dailey,[1] who in 1942 removed a denture from the esophagus by way of the stomach. They, however, used an esophagoscope, and this, we believe, entails most of the difficulties of transoral removal.

We describe our method in the following case report, which also illustrates its advantages.

W. D., a white man aged 46 years, was admitted to the Long Hospital on July 19, 1944. Three days before, while repairing a refrigerator, he swallowed his upper denture when choked by sulfur dioxide. The denture had palatal and gingival plates and four teeth. Next day he had severe pain in his epigastrium on swallowing. This got steadily worse. He passed two tarry stools.

The general condition of the patient was good. Physical examination and examination of the blood and urine showed no noteworthy abnormality except severe

Read at the fourth annual meeting of the Central Surgical Association, Chicago, Feb. 22, 1947.

1. Boone, H. R., and Dailey, J. E.: Foreign Body (Denture) in the Esophagus. Removal by Means of Gastrotomy and Retrograde Esophagoscopy, U. S. Nav. M. Bull. **41**:167-171 (Jan.) 1943.

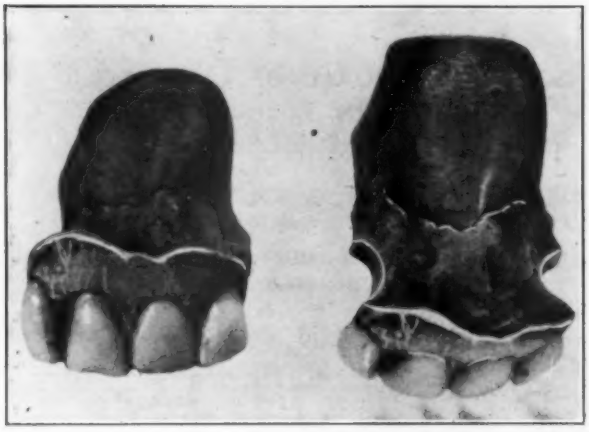

Fig. 1.—Two views of denture.

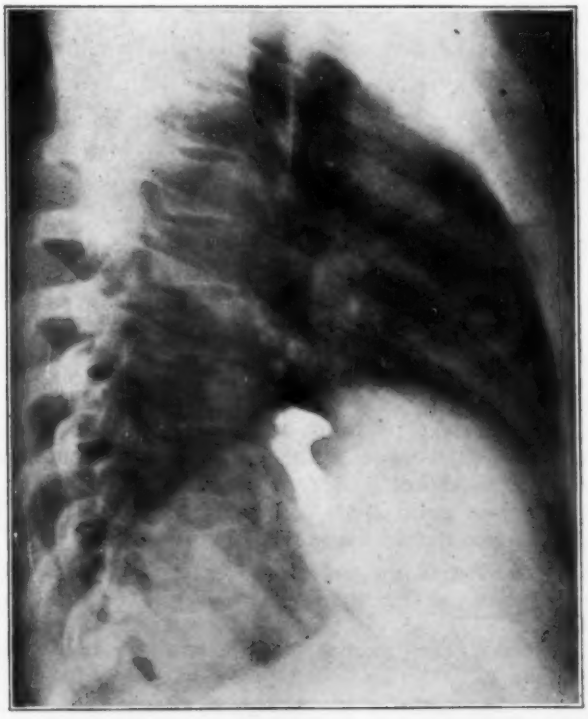

Fig. 2.—Denture lodged in esophagus.

substernal pain on swallowing. The temperature was 98.6 F. and the pulse 105. A roentgenogram showed the denture about 7 cm. above the diaphragm.

On July 21 one of us (W. F. M.) tried to remove the denture with forceps passed through an esophagoscope. He was unable after a prolonged trial to dislodge or break it, though he was able to grasp the teeth, which were uppermost, with a very large forceps. The patient's temperature after this rose to 101 F., and the pain became severe and continuous.

It occurred to the other of us that the denture could be removed from below by passing a sigmoidoscope upward into the esophagus through a small opening into the stomach. We did this operation on July 25 in the following manner. We pulled the cardiac end of the stomach through a short incision made high in the left rectus muscle and made a short longitudinal incision through its anterior wall halfway between the greater and lesser curvatures and near the cardia. An attempt to dislodge the denture through an ordinary short esophagoscope failed. View of the denture was defective, and all efforts to rotate or dislodge it were unsuccessful. We then easily passed a sigmoidoscope (diameter, 2.5 cm.). Through this we had an excellent view of the denture, and we grasped its palatal plate with two forceps and quickly removed it. Closure of the wounds in the stomach and abdominal wall was now done.

Mild bronchopneumonia developed, but otherwise the patient had an uneventful recovery. Healing was by first intention.

We have found that a sigmoidoscope with a diameter of 2.5 cm. can readily be passed up the esophagus of a fresh cadaver as high as the aortic arch. The large diameter of the instrument enables the operator to see what he is doing. It enables him to rotate the foreign body with two forceps applied some distance apart. It also makes its downward passage easy by dilating the esophagus and smoothing out folds of mucosa.

SURGICAL TREATMENT OF PERFORATION OF THE ESOPHAGUS

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CHICAGO

THE MORE widespread use of peroral endoscopy for the diagnosis and therapy of esophageal lesions has kept pace with advances in general and thoracic surgery, which have allowed for the successful treatment of these lesions. Assuming that all who perform these operations are equally skilled, the inevitable risks inherent in the procedure make it seem likely that perforations due to instrumentation alone in the presence or absence of a disease process will occur in some ratio to the number of endoscopic procedures performed. When perforations which occur spontaneously, from peptic ulceration, from ingestion of foreign bodies or from externally inflicted trauma, as in war wounds, blast and other injuries in which rupture is due to sudden marked increase in intraluminal pressure, are added to this number, then it becomes obvious that there is a need for a well defined method of treatment.

Before the advent of sulfonamide and antibiotic therapy and before advances in thoracic surgery had familiarized the surgeon with the mediastinal esophagus, esophageal perforations in the vast majority of instances were followed by the fulminating course of an acute phlegmonous mediastinitis and death. Only those patients survived in whom there was an associated empyema in which drainage might effect a cure or in which the process pointed into the cervical region for drainage as well as the occasional person in whom a mediastinal abscess developed which drained spontaneously and safely back into the esophagus or was successfully drained at an elected time by mediastinotomy.

Since the advent of the sulfonamide compounds, penicillin and streptomycin it is possible that mediastinitis due to esophageal perforation has been aborted in some instances by a regimen consisting of the withholding of oral feedings, the parenteral administration of fluids

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From the surgical departments of the Presbyterian Hospital and the University of Illinois Medical School.

Read at the fourth annual meeting of the Central Surgical Association, Chicago, Feb. 21, 1947.

and the full use of these antibiotic and chemotherapeutic agents. In vitro studies have shown that these drugs are able to keep in check, at least for a few days, the growth of the organisms found in the normal flora of the mouth and the esophagus. Unless there has been a proved perforation of the esophagus, as noted by the endoscopist or the roentgenologist, who may see the escape of radiopaque material from the esophagus on fluoroscopy or the unquestioned widening of the mediastinal shadow in the roentgenogram, or as evidenced by the pathognomonic symptomatology of mediastinitis, then there is no actual proof that mediastinitis has been present.

When positive evidence of perforation is present, then active treatment should be instituted. Adams[1] has concisely stated the problem of acute suppurative mediastinitis. The diagnosis is suspected if in a patient whose temperature, pulse and leukocyte count are normal before an esophageal procedure, there develops thereafter substernal, epigastric or shoulder pain, with an elevation of temperature of one or two degrees Fahrenheit, and of the leukocyte count from levels of 11,000 to 25,000 or 30,000 per cu. mm. If after several hours this pain persists and is made worse by deep inspiration, then the suspicion is clinically confirmed. The additional physical signs which may be present are fulness in the cervical region if the perforation has been in the upper dorsal or lower neck level, tenderness, edema, induration and crepitus.

Roentgenograms made with a portable apparatus are of little help and should not be relied on. The patient should be brought to the x-ray room and given barium for a fluoroscopic study. If there is no perforation, no harm will follow. If a barium droplet escapes from the esophageal lumen, then immediate operation should be performed. Lateral roentgenograms of the neck, in addition to revealing air in the tissue spaces, will demonstrate any change in the normal width of the space between the posterior tracheal wall and the anterior vertebral body. Under ordinary conditions this should not exceed the width of the tracheal column of air. In cases of perforation it is increased beyond this measurement (fig. 5). Other roentgenologic signs include widening of the mediastinal shadow, elevation of the diaphragm and obliteration of the costophrenic or cardiophrenic angles. Small quantities of fluid may be present (fig. 3 *A*).

Adams mentioned a temporary period of apparent improvement, with subsidence of reaction between the sixth and eighteenth hours after injury, occurring in 4 of 7 cases of suppurative mediastinitis marked by a decrease in pain and tenderness and a lowering of the temperature and

1. Adams, R.: Acute Suppurative Mediastinitis, J. Thoracic Surg. **15**:336-340 (Oct.) 1946.

of the leukocyte count. This may give a false impression of improvement, which should be guarded against.

The histories of 4 cases observed over a period of fourteen months follow. No two patients were examined by the same endoscopist.

CASE 1.—G. G., a 54 year old man, was hospitalized for endoscopic study because of a cough which had been present for two weeks. He had had five attacks of loss of voice in the past six months and had been urged by his family to seek medical attention. He also complained of some difficulty in swallowing. On office examination the endoscopist had gained the impression that there was a mass protruding into the posterior tracheal wall. Roentgenograms were said to have shown a narrowing of the air column at this point. The preoperative roentgenogram of the chest demonstrated a normal mediastinum. The temperature, pulse and leukocyte count were within normal limits on the patient's admission to the hospital.

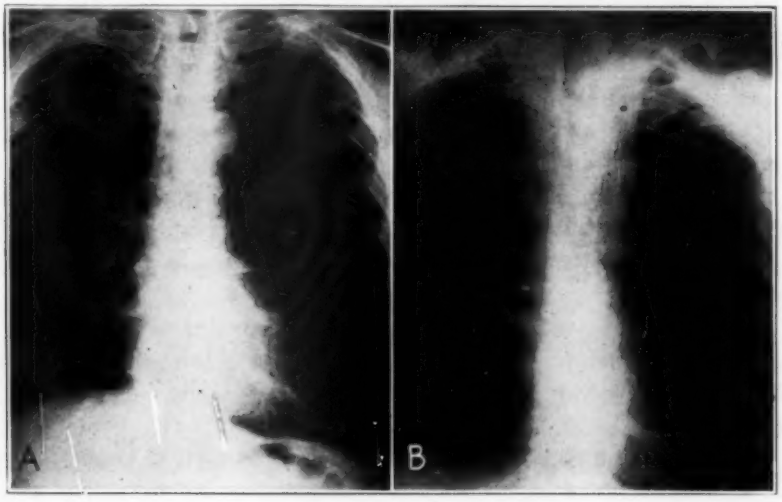

Fig. 1 (case 1).—*A*, roentgenogram of the chest made before endoscopy. Mediastinal shadow is normal. *B*, roentgenogram made after endoscopy. The haziness and widening of the upper dorsal and lower cervical part of the mediastinum is apparent.

It was noted at the time endoscopy was performed that at a distance of 21 cm. from the incisor teeth a firm mass of black pigmented tissue resembling mediastinal lymphoid tissue protruded from the left wall and almost completely obliterated the esophageal lumen. A specimen of this tissue was removed for microscopic examination.

On the evening of the day of examination the patient's rectal temperature rose to 104 F. and the leukocyte count, previously normal, was now 17,000. Perforation of the esophagus was suspected. Treatment with 30,000 units of penicillin every three hours was begun, and fluids orally were withheld. The patient's temperature became lower and his general condition continued to be good despite the development of swelling in the left cervical region, which became progressively larger in the postoperative days. Crepitus was evident and the

swelling was tender. Hot compresses were applied, and on this management swelling subsided and the patient left the hospital on the ninth postoperative day.

Figure 1 *A* shows the roentgenogram of the chest taken before endoscopy and figure 1 *B* that taken on the first postoperative day. The difference in the width of the mediastinal shadow is apparent.

Comment.—Subsidence of the mediastinal inflammatory process occurred in this instance without resort to surgical drainage. Surgical consultation was not sought until two days after endoscopy. If the patient had been seen earlier, cervical mediastinotomy would certainly have been advised immediately.

Case 2.—F. D., a 51 year old woman, was admitted to a hospital for esophagoscopy after having been seen by the endoscopist on the morning of the day of

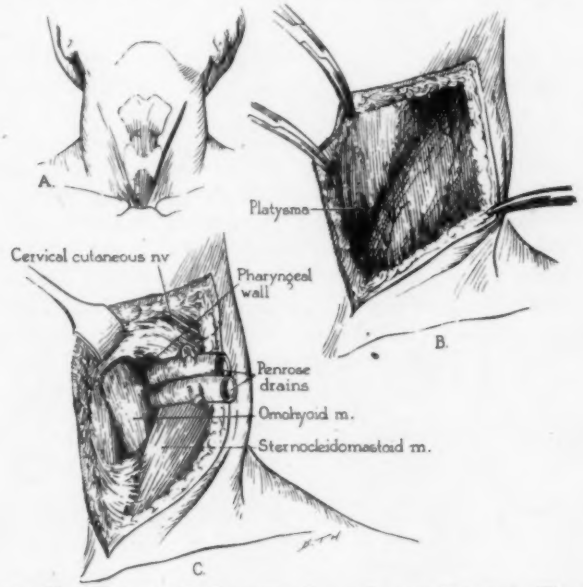

Fig. 2 (case 2).—The cervical approach to the esophagus is illustrated, beginning with the skin incision (*A*) down to the cervical part of the mediastinum. The omohyoid muscle may be displaced upward and the drains placed below it if desired.

admission. The history indicated that one week before the patient had noted a sore throat almost immediately after the ingestion of beef broth. Soreness had increased thereafter. Swallowing was difficult and painful. Physical examination revealed swelling, redness, induration and crepitation along the lower anterior border of the left sternomastoid muscle.

Esophagoscopy was performed with the patient under general anesthesia, and it was noted that on the posterior esophageal wall there was a black necrotic region, which was apparently the point of perforation. Without the patient being allowed to awaken, mediastinotomy was perfomed in the left cervical region through the approach illustrated in figure 2. When the region of the esophagus was reached, foul-smelling, watery pus was seen to escape. Culture of the material produced an abundant growth of hemolytic Staphylococcus aureus.

The patient's temperature was 101.6 F., the pulse rate 110 and the leukocyte count 14,300. No roentgenologic studies were made. In the postoperative period, 30,000 units of penicillin every three hours was administered, and all fluids were withheld in favor of parenteral administration for five days. At the end of that time feedings were begun, and when no leakage was demonstrated the drains were removed. The patient was discharged on the eighth postoperative day.

Comment.—Cervical mediastinotomy can be simply and safely performed in instances in which esophageal perforation has led to an inflammatory process pointing into the cervical region. It has been stated [2] that drainage in this region is a satisfactory treatment for perforations as low as the level of the fourth dorsal vertebra. As an adjunct to posterior mediastinotomy, it serves well for the establishment of through and through drainage.

CASE 3.—S. H., a 57 year old man, was admitted to a hospittal three hours after a piece of beef was reported to have lodged in his esophagus. He had had several similar experiences previously, each of which was associated with some emotional disturbance. None of these had required medical treatment. After preparation, esophagoscopy was carried out two hours after admission. There was some difficulty because of the inability of the patient to relax. Removal of the meat bolus was not accomplished. The patient was returned to his room and allowed to take water by mouth. Almost immediately thereafter he complained of severe pain in the epigastrium and chest at the level of the tenth dorsal vertebra. Half a grain (0.03 Gm.) of morphine did not bring relief. His temperature, which had previously been normal, rose to 103 F. The leukocyte count within five hours had risen to 25,000 per cubic millimeter. Figure 3 *A* is a roentgenogram of the chest taken at that time, which shows clouding with some fluid perhaps in the cardiophrenic and costophrenic angles. Surgical intervention was deemed necessary.

Operation was performed jointly with Dr. H. E. Jones. The left side of the chest was opened through the bed of the ninth rib, and the pleural space was freed. In the region of the costovertebral gutter a small quantity of thin turbid fluid was present. The mediastinal pleura was divided between the aorta and the pericardium, and the esophagus was exposed. There was no demonstrable gross area of perforation, but there was edema of the mediastinal tissues. The solidly impacted meat bolus lay just above the esophageal hiatus of the diaphragm. Because there had been a question of perforation of the esophagus at the esophagogastric junction, the diaphragm was opened, but exploration of the upper part of the abdomen did not disclose any pathologic change. Gastrotomy was performed, and it was possible to deliver a portion of the bolus with a curved forceps passed into the esophagus from the stomach. The bulk of it, however, could not be removed. The endoscopist then introduced the esophagoscope and extracted what remained with considerable ease. The wall of the chest was closed after reexpansion of the lung. The mediastinal pleura was not closed. A catheter was led from this point over the dome of the diaphragm through the interspace below the incision.

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2. Gaudiani, V.: The Surgical Treatment of Suppurations in the Posterior Mediastinum, Ann. Surg. **63**:523-532 (May) 1916.

The patient was given oxygen. Oral administration of fluids was withheld and parenteral infusions given. Adequate replacement of blood was ensured by transfusion. Doses of 100,000 units of penicillin and 250,000 units of streptomycin as well as sulfonamide compounds were also given parenterally.

Figure 3 *B* shows the appearance of the chest in a roentgenogram made with a portable apparatus five days after operation. On the evening of the fifth day there was sudden respiratory difficulty, which was determined to be due to a tension pneumothorax in the right side of the chest. Figure 3 *C* is a roentgeno-

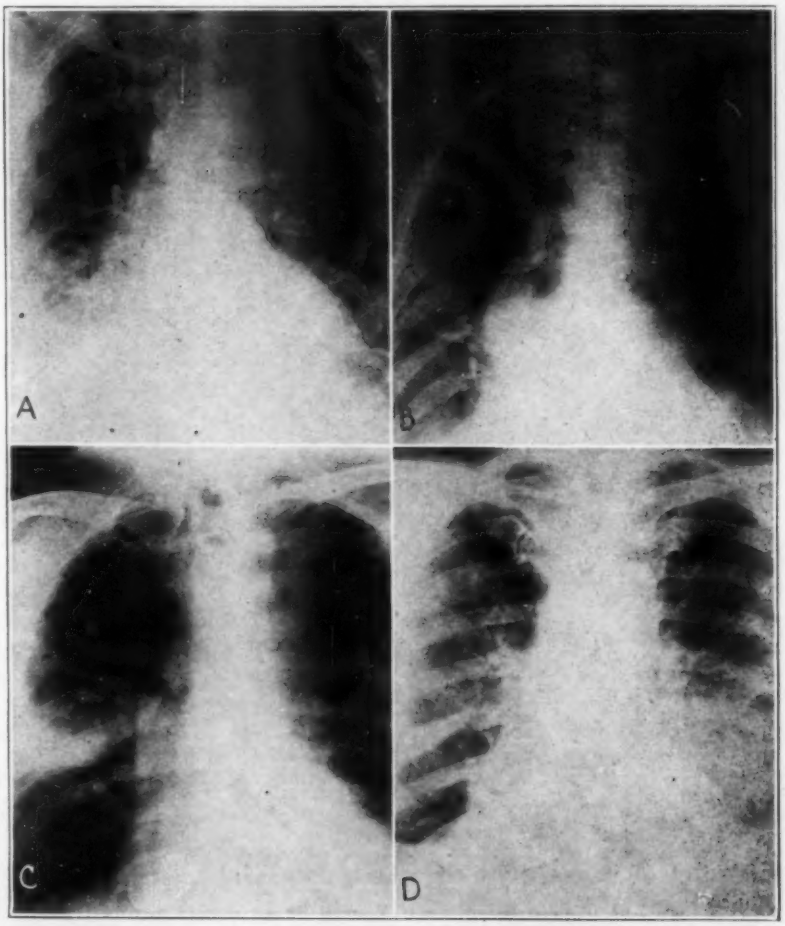

Fig. 3 (case 3).—*A*, roentgenogram of the chest taken five hours after endoscopy, showing cloudiness in the base of the right pulmonary field due to fluid in the costophrenic angle. There is also some widening of the mediastinal shadow. *B*, portable roentgenogram of the chest five days postoperatively. There is some deviation of the mediastinum to the right with cloudiness in the base of the right lung field. *C*, portable roentgenogram of the chest after development of tension pneumothorax on the right. The needle used for continuous water-seal drainage is visible in the right upper pulmonary field. The rounded areas of increased density in the right hilar area were considered to be calcified glands. *D*, roentgenogram of the chest on discharge of the patient from the hospital three weeks after operation. The right lung is completely expanded.

gram made with the needle in place through which water-seal drainage was established. Convalescence thereafter was uneventful. Feedings were begun on the seventh postoperative day. Subsequent roentgenograms of the esophagus have revealed this to be entirely normal. Figure 3 *D* is a roentgenogram of the chest made at the time of the patient's discharge from the hospital, three weeks after operation.

Comment.—This unusual case stresses the importance of the treatment of esophageal obstruction due to the impaction of meat by the method advocated by Richardson.[3] The latter's attention was called to the digestive action of "caroid." The chief constituent of "caroid" is papain or vegetable pepsin, which comes from the fruit and leaves of the papaw tree. Papain contains enzymes similar to those in pepsin, but they act in acid, neutral or alkaline medium. Ordinary papain

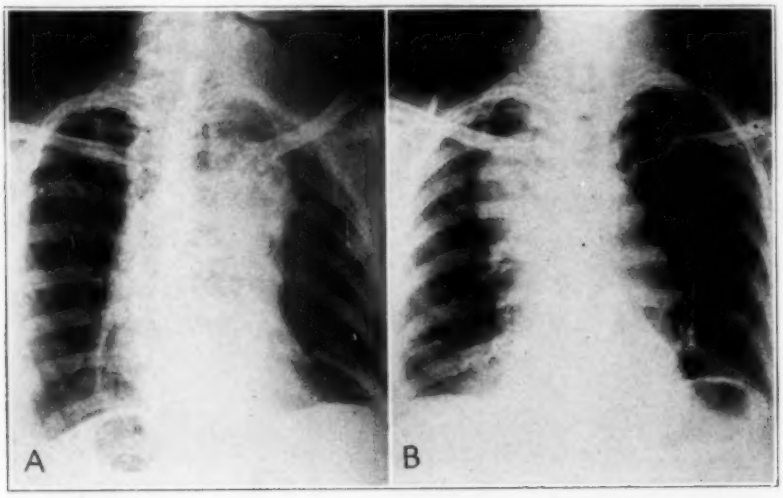

Fig. 4 (case 4).—*A*, oblique roentgenogram of the chest after oral ingestion of barium. Barium droplets can be seen to the right of the vertebral column outside of the esophageal lumen, indicative of esophageal perforation. *B*, anteroposterior roentgenogram of the chest, demonstrating widening of the mediastinal shadow most marked at the level of the fifth and sixth posterior dorsal ribs because of mediastinal abscess.

is said to digest about thirty-five times its weight of lean meat. The grayish white powder is incompletely soluble in water and in glycerin. It may be obtained from the druggist commonly combined with sodium bicarbonate, ginger, pepsin or bile salts and in many other combinations. Richardson recommended a 5 per cent solution of papain in a 10 per cent solution of alcohol. This makes a stable stock solution. One cubic centimeter is administered every fifteen minutes. When a tea-

3. Richardson, J. R.: A New Treatment for Esophageal Obstruction Due to Meat Impaction, Ann. Otol., Rhin. & Laryng. **54**:328-348 (June) 1945.

spoonful can be taken, the action is more effective. Richardson emphasized the frequency of obstruction by bolus in persons who have false upper plates. He has reported the use of this digestive in 17 patients with complete esophageal obstruction, both high and low. In only 1 patient was esophagoscopic removal necessary, and this patient could not retain the papain. Either vomiting or swallowing of the foreign body occurred in 12 of the remaining 16 within one and a half hours. The longest time was seven and a half hours. All the patients had received injections of morphine sulfate to relax the esophageal spasm and allow for passage of the obstructing material before the use of papain was resorted to.

This treatment is worthy of consideration particularly in cases in which endoscopy is difficult because of the patient's physical or emotional

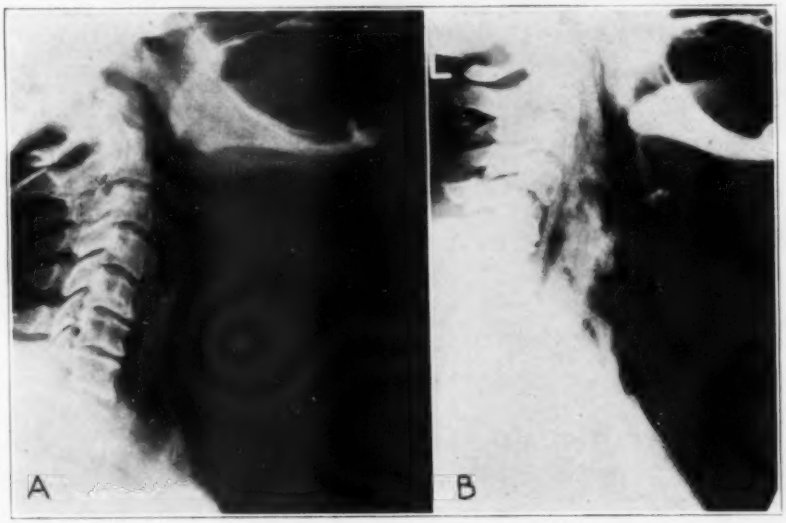

Fig. 5 (case 4).—*A*, lateral roentgenogram of the cervical region, taken before endoscopy, showing normal width of the space between the tracheal air column and the interior margin of the cervical vertebrae. *B*, comparative view taken five days after endoscopy, at time of visualizaion with barium, showing great increase in width of this space, with air in the soft tissues indicative of cervical emphysema.

nature. In the case which has been reported the treatment might have substituted for the surgical intervention described.

Operation was considered necessary to remove the bolus in the presence of the perforation. The left side of the chest was entered because of the suspicion of perforation at the esophagogastric junction and the greater ease of approach to the esophagus even though the major roentgenologic changes were in the opposite side. Gastrotomy was performed rather than opening of the esophagus at the site of the bolus because it was felt that removal of the bolus could be accomplished without weakening the esophageal wall, whose healing properties,

perhaps, are not as great as those of serum-covered viscera. The mechanism of the tension pneumothorax which came on five days later is not completely understood. It may have resulted from atelectasis of the right lung, with rupture of a surface bleb subjected to the increased negative pressure associated with atelectasis. Gastrostomy might have been employed to advantage, preliminary to thoracotomy.

CASE 4.—G. S., a 54 year old woman, was admitted to a hospital for esophagoscopy after ingestion of a piece of lamb chop, which had lodged in her esophagus. Esophagoscopy did not reveal the presence of the foreign body. There was some bleeding after the endoscopic procedure, which promptly subsided. The patient's temperature rose to 101 F. on the first postoperative day. On the fifth postoperative day fluoroscopic study after administration of barium was carried

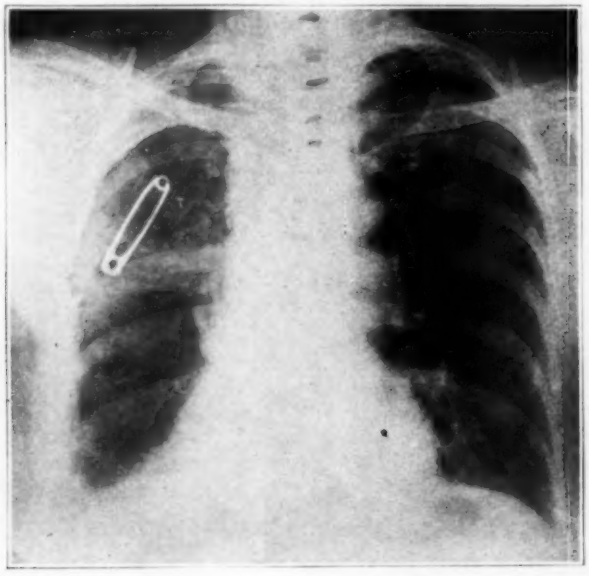

Fig. 6 (case 4).—Roentgenogram of the chest taken after mediastinotomy, showing mediastinal shadow slightly increased in width but disappearance of mediastinal abscess.

out. Figure 4 *A* is an oblique roentgenogram of the chest showing the accumulation of barium in the mid-portion outside of the esophageal lumen. Figure 4 *B* is an anteroposterior view of the chest showing the considerable widening of the mediastinal shadow, with a rounded swelling most prominent at the level of the right sixth rib posteriorly. A mediastinal abscess was apparent. Figure 5 is a lateral view of the cervical region taken before endoscopy, showing a normal width of the space between the air column and the vertebrae and the much increased width, with air in the soft tissues, five days later.

A Witzel type of gastrostomy was performed with the patient under general anesthesia. She was then placed with her right side upward, and a mediastinotomy was carried out through the resected posterior portion of the right sixth rib.

Figure 6 is a roentgenogram of the chest three weeks later showing the adequacy of the drainage of the mediastinum. The gastrostomy tube had been removed and feedings resumed.

Comment.—The management of this patient includes all the essential points in the care of esophageal perforation with suppurative mediastinitis. This is the most serious type and has, as has been stated, most often resulted in death. Its immediate recognition, to be followed by immediate surgical treatment, is important. Gastrostomy performed with the patient under the same intratracheally administered anesthetic as for mediastinotomy should, of course, be done preliminarily. Mediastinotomy should be performed at the level of the greatest prominence of the mediastinal widening.[4] After resection of the posterior portion of the rib, the posterior periosteum should be gently retracted anteriorly, and this may be facilitated by the removal of sections of ribs above the longer length of rib removed primarily. It is to be emphasized that dissection of the parietal pleura forward may easily result in a tearing. If this occurs, the opening must be packed and closed and Penrose drains allowed to remain so that drainage from the mediastinal abscess may be directed along that course and not into the open pleura. In the presence of signs of inflammation in the neck the procedure may be combined with cervical mediastinotomy for greater effectiveness. Suction may be applied for several days, as recommended by Adams. The presence of the gastrostomy opening for the administration of fluids and food as well as sulfonamide compounds is of great help and should not be undervalued.

Finally, it is to be emphasized that the most effective results from the treatment of pathologic changes subsequent to esophageal perforations are to be obtained only by methods which are considered adequate. These methods have been discussed.

55 East Washington Street.

4. Lilienthal, H.: Thoracic Surgery, Philadelphia, W. B. Saunders Company, 1926, vol. 1, pp. 266-281.

RESECTION OF THE ESOPHAGUS FOR PERSISTENT STRICTURE

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"TO THE surgeon there are but three diseases of the esophagus: cardiospasm, diverticulum and scar stenosis. The only other common disease is carcinoma, in which he is helpless." These words were written by Hertzler [1] in 1936, and the passing of a decade has made them no longer applicable. As a result of the tremendous advances in anesthesiology, in surgical technic and in the use of antibiotics, the thoracic cavity can be entered with greater safety. Lesions of the esophagus have become accessible, and carcinoma of the esophagus is now a surgical problem. It can be successfully treated if an early diagnosis is made. Any portion of the intrathoracic esophagus can be removed and an anastomosis made between the stump of the esophagus and the stomach or small intestine within the thoracic cavity. Such procedures are still formidable, however, and are accompanied with a high mortality, as is shown in statistical reviews.

In a total number of 195 cases collected from the literature in 1941 by Ochsner and de Bakey,[2] in which esophageal resections were performed at all levels, death occurred in 140, giving an operative mortality of 71.8 per cent. Adams [3] in 1941 collected 34 cases in which sixty-eight operations were performed by twelve surgeons, with a 50 per cent mortality. In 1942 Phemister [4] reported the performance of resection and esophagogastrostomy in 4 cases, with a 50 per cent mortality.

Read at the fourth annual meeting of the Central Surgical Association, Chicago, Feb. 22, 1947.

1. Hertzler, A. E.: Surgical Pathology of the Gastro-Intestinal Tract, Philadelphia, J. B. Lippincott Company, 1936.

2. Ochsner, A., and de Bakey, M.: Surgical Aspects of Carcinoma of the Esophagus: Review of Literature and Report of Four Cases, J. Thoracic Surg. **10**:401-445 (April) 1941.

3. Adams, W. E.: Recent Progress in the Surgical Treatment of Carcinoma of the Esophagus, Surg., Gynec. & Obst. **72**:312-317 (Feb.) 1941.

4. Phemister, D. B.: Experiences with Eight Cases of Resection of the Esophagus for Carcinoma, J. Thoracic Surg. **11**:484-493 (June) 1942.

Stephens [5] reported a mortality of 60 per cent following resection and Garlock [6] a mortality of 38 per cent. Of course, these figures are based on resection for carcinoma, but they represent the operative mortality. The postoperative mortality, which covers deaths from recurrent carcinoma, is even greater. In fact, the survival of a patient for two and one-half years after esophageal resection for carcinoma has been a medical curiosity. In contrast to this, the outlook following resection of the esophagus for stricture is much better, and though the operation is formidable, from the standpoint of longevity it is more favorably employed than resection for carcinoma.

Strictures of the esophagus which occur after chemical burns are encountered frequently and present a serious problem because the accompanying stenosis results in starvation unless some other avenue for nutrition is established. For this reason, gastrostomy for feeding has been used for many years. It has many disadvantages, however. The method of injecting food into the stomach is unsatisfactory to many patients, some of whom prefer starvation rather than life maintained in that manner. The inability to enjoy the taste of food is distressing. Although certain technics of gastrostomy minimize the amount of leakage, constant dressings are always necessary, and this too is a tribulation to the patient. Various types of procedures have been designed to reestablish the connection between the mouth and the stomach so that food can be chewed and swallowed.[7] Tubes of intestine and skin external to the bony thorax have been constructed and in a small percentage of cases have functioned satisfactorily. The majority

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5. Stephens, H. B.: Cancer of the Thoracic Esophagus and the Upper End of the Stomach: Review of Twenty-Three Cases That Have Undergone Surgical Exploration, J. Thoracic Surg. **11**:469-483 (June) 1942.

6. Garlock, J. H.: Causes of Mortality Following Radical Resection of the Esophagus for Carcinoma, J. Thoracic Surg. **13**:415-430 (Oct.) 1944.

7. Adams, W. E., and Phemister, D. B.: Carcinoma of the Lower Thoracic Esophagus: Report of a Successful Resection and Esophagogastrostomy, J. Thoracic Surg. **7**:621-632 (Aug.) 1938. Adams, H. D.: Carcinoma of the Esophagus, S. Clin. North America **22**:709-719 (June) 1942. Garlock, J. H.: The Reestablishment of Esophago-Gastric Continuity Following Resection of Esophagus for Carcinoma of Middle Third, Surg., Gynec. & Obst. **78**:23-28 (Jan.) 1944. Ochsner, A., and Owen, N.: Antethoracic Oesophagoplasty for Impermeable Stricture of the Esophagus, Ann. Surg. **100**:1055-1091 (Dec.) 1934. Sweet, R. H.: Transthoracic Resection of the Esophagus and Stomach for Carcinoma: Analysis of Postoperative Complications, Causes of Death and Late Results of Operation, ibid. **121**:272-284 (March) 1945; Surgical Management of Carcinoma of the Midthoracic Esophagus: Preliminary Report, New England J. Med. **233**:1-7 (July 5) 1945, Taylor, H.: Operation for Removal of Carcinoma of Oesophagus with Presternal Esophagogastrostomy, Brit. J. Surg. **32**:394-399 (Jan.) 1945. Torek, F.: First Successful Case of Resection of Thoracic Esophagus, Surg., Gynec. & Obst. **16**:614-617 (June) 1913. Yudin, S. S.: The Surgical Construction of Eighty Cases of Artificial Esophagus, ibid. **78**:561-583 (June) 1944.

become obstructed, or the anastomoses break down and leakage occurs. Repeated esophagoscopic dilations may sufficiently expand the esophagus to allow the passage of liquids even in the intractable cases. This procedure, however, is palliative at best and rarely curative. Frequent dilation is necessary during the remainder of the patient's life, and intake of food usually is restricted to liquids. Surgical advancements in the treatment of carcinoma of the thoracic esophagus have suggested a new approach to the treatment of esophageal stricture. Most chemical strictures occur at points of anatomic narrowing, i. e., at the level of the cricoid cartilage, the aortic arch or the left bronchus and at the opening through the diaphragm. Those which are most severe and which do not respond to dilation usually occur at the level of the aortic arch, as in the cases to be presented here.

Although esophageal strictures occur high in the chest and necessitate the removal of the esophagus at a level above the aortic arch, mobilization of the stomach and the maintenance of its vascularity can be accomplished in such a manner that this organ can be elevated to the dome of the pleural cavity. It can be anastomosed to the esophagus at a level above the site of most strictures. In spite of the fact that this procedure carries with it a greater operative mortality than other surgical procedures employed for esophageal stricture, it is justifiable because it restores continuity to the gastrointestinal tract, thus enabling the patient to taste and ingest his food in a normal manner and to lead a normal life, with little or no discomfort. It also overcomes the psychologic handicap which frequently leads to death by starvation or suicide in patients with persistent stricture.

TECHNIC

A technic for thoracic esophagectomy and gastroesophageal anastomosis was described by Sweet, who reported success in 3 cases.[8] His approach is through the bed of the left eighth rib and consists of excision of the esophagus from its junction with the stomach to a level above the stricture, which is usually posterior to the aortic arch. The diaphragm is then incised and the stomach mobilized, all attachments down to the pylorus being divided but the right gastric and right gastroepiploic arteries being preserved to maintain an adequate circulation to the stomach especially at the site of the anastomosis. The anastomosis is then made between the proximal end of the esophagus and the anterior wall of the antrum of the stomach. The mobility of the stomach even after one or more gastrostomies have been performed is surprising, and the anastomosis can be made in most instances with little or no

8. Sweet, R. H.: Subtotal Esophagectomy with High Intrathoracic Esophagogastric Anastomosis in the Treatment of Extensive Cicatricial Obliteration of the Esophagus, Surg., Gynec. & Obst. **83**:417-427 (Oct.) 1946.

tension on the suture line. We have made a few modifications in the technic of Sweet, which facilitate the procedure in our hands. Resection of the eighth rib and posterior division of the seventh and sixth ribs give easy access to the entire stomach. However, with this approach it is technically difficult to perform the anastomosis between the stomach and esophagus if this must be done at the dome of the left pleural cavity. By removal of the seventh rib and division of the sixth and fifth ribs, we have found the entire stomach to be accessible and the gastroesophageal anastomosis to be considerably simplified. It has also been our policy to insert a Rawson-Abbott tube through the anastomosis. The proximal end of this sterile tube is passed in a retrograde manner up through the esophageal stump to be retrieved by the anesthetist. The distal end is then passed into the stomach, with the extension for feeding well down into the duodenum. Since the vagus nerves are of necessity divided in this operation, the stomach becomes markedly distended if constant gastric suction is not used postoperatively. Distention may produce undue tension and necrosis at the suture line, and it also compresses a considerable portion of the left lung. By constant aspiration and by the administration of duodenal feedings immediately after operation the stomach can be kept deflated until healing takes place. At the same time the patient's state of nutrition can be maintained.

As the left gastric, left gastroepiploic and short gastric arteries are all divided in mobilization of the stomach, it is most important to maintain the circulation provided by the right gastric and right gastroepiploic arteries, as has been emphasized by Sweet. In 1 of our patients the right gastroepiploic artery had been divided in the mid-portion of the stomach during a previously performed gastrostomy. After mobilization of the stomach, therefore, the right gastric artery was the only source of arterial blood supply to the stomach. This supply was inadequate to the degree that the proximal half of the stomach became somewhat cyanotic and a fistula subsequently developed at the site of the gastroesophageal anastomosis. Although this finally healed, it prolonged the convalescence of the patient and added a hazard to the operation. Stress should be placed on the importance of preserving the right gastric and right gastroepiploic arteries in making a gastrostomy for stricture of the esophagus if a subsequent esophagectomy is contemplated.

ANATOMIC CONSIDERATIONS

There are certain anatomic relationships which merit attention, at least theoretically, during resection of the esophagus:

1. Disturbances in the circulatory system may occur as a result of interference with the plexus of nerves formed by the vagi and the sympathetic trunks around the esophagus.

2. The upper end of the thoracic esophagus should be resected high in the thorax as that portion depends on the inferior thyroid branch of the thyrocervical trunk for its blood supply. Esophageal branches from the descending thoracic aorta, the left gastric branch of the celiac artery and branches from the left inferior phrenic branch of the abdominal aorta are ligated during the mobilization of the esophagus.

3. The left recurrent laryngeal nerve courses between the esophagus and the trachea in the superior mediastinum. Injury to the nerve may result in paralysis of the vocal cord.

4. At one point along its course the esophagus is in close approximation to the left bronchus. Bronchial punctures have been reported during dissection of the esophagus, but if recognized at the time of operation they can be repaired without ill effect.

5. Mobilization of the esophagus behind the arch of the aorta is accomplished blindly. Branches of the aorta or the aorta itself in this location may be torn.

6. The thoracic duct extends along the left side of the esophagus and can be torn easily. If this occurs, it must be ligated to prevent chylous hydrothorax with resultant inanition, which is usually fatal.

7. The lymphatic vessels of the esophagus form a plexus around it, and the collecting vessels from the plexus drain into the posterior mediastinal glands. Contamination at the time of resection can produce a severe mediastinitis. These posterior mediastinal lymph glands usually end in the thoracic duct, but some join the tracheobronchial glands. This may explain the bronchopneumonia which often develops postoperatively.

Many of these considerations are largely theoretic, and few of the structures mentioned are actually identified at operation. The fibrosis which exists around the esophagus as a result of the periesophagitis produced by the caustic substance ingested results in a dense mass of scar tissue, within which the esophagus is embedded and from which it must be separated by sharp dissection. If a line of cleavage is kept as close to the esophagus as possible, injury to surrounding structures is not likely to occur.

PREOPERATIVE AND POSTOPERATIVE CARE

Most patients presenting themselves for surgical care of esophageal stricture are in a poor state of nutrition and give a history of having lost from 25 to 75 pounds (11 to 34 Kg.) in weight. Every effort must be made to improve their nutrition before an extensive surgical procedure is undertaken. If an adequate gastric opening exists, concentrated feedings should be given for a fairly prolonged period. Dilation of the esophagus to permit the introduction of a tube for preoperative

feeding purposes together with the parenteral administration of proteins, carbohydrates and vitamins will lessen the surgical risk. Prior to operation a normal blood picture must be established, and ample blood must be available for administration during the operation to overcome effects of loss of blood and possible shock. We have administered from 1,500 to 2,500 cc. of blood during the course of each procedure.

The postoperative care after esophagectomy must be intensive and vigilant. Inhalations of carbon dioxide every half hour for the first twelve to twenty-four hours are given, the patient is turned frequently and deep breathing is encouraged. Block of intercostal nerves to diminish pain and encourage deep breathing helps to diminish pulmonary complications. In the administration of medication for pain, meperidine hydrochloride and other barbiturate mixtures are of more value than morphine, which depresses the cough reflex. Oxygen is given only if there is severe mediastinal shift or evidence of oxygen want. Nutrition can be maintained by duodenal feedings through the Rawson-Abbott tube and the parenteral use of proteins, carbohydrates, vitamins and fluids. Gastric suction should be maintained for approximately seven days. The aspirated gastric juice can be strained and readministered through the duodenal tube in divided amounts with the feedings if prolonged suction is necessary. It is advisable to give blood on two or more occasions during the immediate postoperative period. Contamination cannot be avoided in the performance of the open anastomosis. The use of streptomycin and penicillin helps to control infection. Pulmonary and pleural complications invariably are encountered. At the conclusion of the operation, bronchoscopic aspiration is routinely performed, and it is repeated whenever evidence of bronchial obstruction arises. The large area of denuded tissue from dissection of the esophagus and the presence of the stomach and some omentum in the pleural cavity result in the accumulation of fluid in the left pleural cavity. For this reason, a catheter drain is placed into the chest and a closed system of drainage instituted, a Stedman pump regulated at approximately normal intrapleural negative pressures (5 to 10 mm. of mercury) being used. This tends to prevent compression of the left lung, accumulation of fluid and subsequent empyema. Blood clots frequently occlude this drain, which must be carefully watched and irrigated when necessary. Solution of penicillin is used, about 300,000 units being instilled in a small amount of sterile water after each irrigation. Expansion of the lung should be encouraged by the use of blow bottles.

PRESENTATION OF CASES

Four cases of intractable stricture of the esophagus treated in the manner outlined are presented:

CASE 1.—J. M. P. was a 25 year old Negro factory worker. On Oct. 26, 1945, after drinking hard liquor all day, he desired water but swallowed lye by mistake.

He was seized with substernal pain and cramps in the abdomen and was taken to a hospital, where first aid was rendered. Later he was transferred to the Veterans Administration Hospital, Jefferson Barracks, Mo., with the chief complaint of dysphagia. A diagnosis of chemical stomatitis and esophagitis was made. Several days later the entire mucosal lining of the oropharynx and esophagus sloughed. Roentgenographic evidence of a stricture of the esophagus was obtained, after which he was transferred to the Veterans Administration Hospital, Hines, Ill., on Jan. 17, 1946. At that time he weighed 105 pounds (47.6 Kg.). At the onset of his illness he had weighed 190 pounds (86.2 Kg.).

A gastrostomy of the Janeway type was performed on February 12. While the patient was being fed through the gastrostomy opening, dilations were continued. The principal stricture was found to be located 21 cm. from the teeth (fig. 1). The roentgenograms on January 30 had revealed a conical constriction at the level of the clavicle and a decrease in the caliber of the lumen below that point as well as an acquired pulsion diverticulum above the stricture.

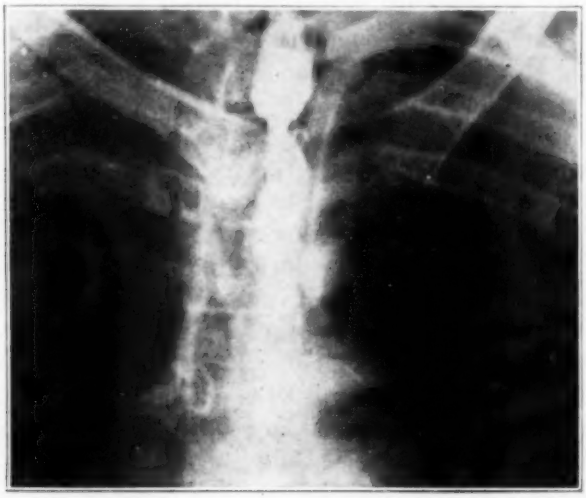

Fig. 1.—Study of esophagus after administration of barium showing stricture above the level of the clavicles, with secondary strictures below.

By May 2 the strictured area had been dilated sufficiently to admit a size 20 bougie. On July 23 the consultant noted that the stricture was still present and that it needed constant dilation if the patient were to be able to partake of anything besides liquids. Because he did not respond satisfactorily to instrumentation, he was considered to be in need of esophageal resection. The operation was performed on November 20, and his postoperative course was uneventful.

Electrocardiograms taken before and after operation showed a normal condition.

Histologic examination of the excised esophagus disclosed a diffuse fibrosis in the wall encroaching on the mucosa. The mucosa was hyperplastic and markedly thickened. There was also fibrous substitution of the muscularis, causing atrophy of the muscle cells, as well as a diffuse inflammatory reaction. There was considerable fibrous substitution between the muscular planes, causing wide separation.

Roentgenographic study on December 20 after the ingestion of barium showed that the esophagus at the level of the aortic arch looped to the left and was tortuous in appearance. The esophagus entered the stomach above the level of

the suprasternal notch. There was negligible displacement of the mediastinum to the right (fig. 2).

On Jan. 31, 1947, the patient was asked to swallow a Levine tube. To this an air bulb such as is used with a proctoscope was attached, and the thoracically placed stomach was distended with air and examined roentgenologically. This study revealed a large gas-filled stomach extending from the level of the posterior third rib on the left to the diaphragm. It showed the stomach distended with air and occupying the inner and middle zones of the pulmonary field (fig. 3).

On February 11 the patient was discharged weighing 130 pounds (59 Kg.). His only complaint was a slight feeling of fulness after meals. He was eating three large meals daily and was advised to eat smaller amounts more frequently.

Fig. 2.—End result of esophagectomy, showing esophagus and esophagogastric anastomosis to be of good caliber, with the greater portion of the stomach in the thoracic cavity.

He had no difficulty in swallowing solid foods and was well satisfied with the result.

CASE 2.—P. J., a 25 year old Negro janitor, while intoxicated in March 1945, was given a glass of lye to drink. He was treated for stricture of the esophagus at the City County Hospital, Fort Worth, Texas, and for bronchial asthma of two years' duration characterized by attacks of wheezing occurring every four weeks and lasting for one week at a time.

On June 30, 1945, the patient was admitted to the Veterans Hospital, Muskogee, Okla., and from there he was transferred to the Veterans Administration Hospital,

Hines, Ill., on July 3 for further treatment for strictured esophagus. At that time he weighed 120 pounds (54.4 Kg.).

Intravenous feeding was necessary until a gastrostomy could be performed. Numerous dilations were then carried out, both retrograde and peroral.

An esophagogram on July 10 revealed all segments of the proximal third, which was extremely narrowed. The distal two thirds could not be visualized.

After a period of hospitalization of three hundred and eighty-seven days, the patient was given a set of dilators and was discharged on July 27, 1946. Two weeks later he returned again because of difficulty in swallowing. At this time only a size 14 bougie could be passed through the two most severely strictured

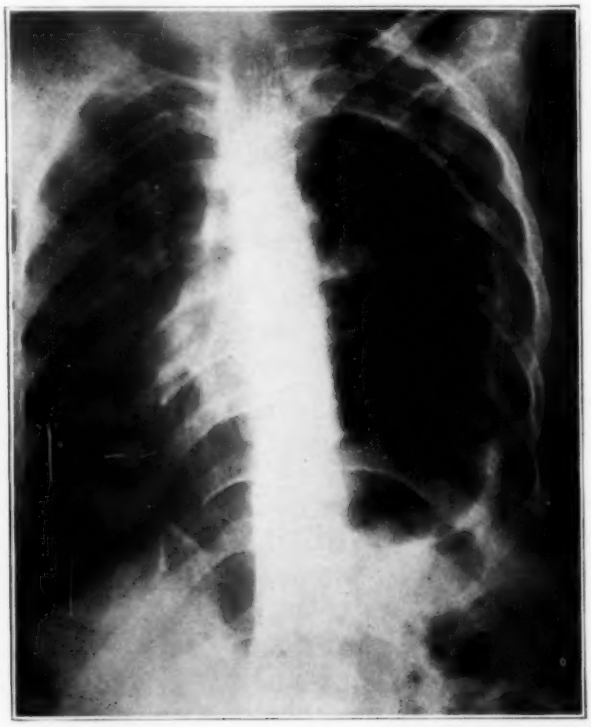

Fig. 3.—Stomach distended with air to show size and position in thoracic cavity.

areas at 22 and 32 cm. respectively from the teeth. Although the patient had a gastrostomy opening, he refused to use it.

On Dec. 4, 1946, esophageal resection was accomplished. At operation it was found that in order to get above the stricture it was necessary to perform the esophagogastric anastomosis at a higher level than had been anticipated. The esophagus had to be mobilized above the dome of the left pleural cavity and pulled downward. The anastomosis then had to be made about 2 inches (5 cm.) above the arch of the aorta, which increased the difficulty of the procedure. When the anastomosis was completed, the suture line retracted beyond the edge of the mediastinal pleura. The edges of the pleural opening were sutured to the stomach, and the stomach was anchored to the posterior parietal pleura. Although there

was no redundancy to the stomach, the anastomosis did not appear to be under undue tension.

The pathologic changes in the specimen were similar to those described in the previous case (fig. 4).

The postoperative course was not uneventful. Two days after operation atelectasis of the lower lobe of the right lung developed, and bronchoscopy was required. After bronchoscopy, bronchopneumonia in the base of the lung occurred, and there was noticeable mediastinal shift. Although the patient's temperature gradually returned to normal, some fluid was still present in the left pleural cavity on Jan. 1, 1947. By Christmas time he had been eating a regular diet. The electrocardiogram taken preoperatively was normal, but one taken after full postoperative recovery was described as follows: "Abnormal limb leads suggest coronary insufficiency or pleural effusion or acid-base imbalance." There was a depressed ST segment.

At the present time this patient's only complaint is distress following meals, described as a "feeling of fulness." He has had no attacks of asthma since his operation.

Fig. 4.—Longitudinal section of excised esophagus, showing strictured area.

CASE 3.—B. K., a 27 year old white painter with psychosis connected with his service in the Army, was admitted to the Veterans Administration Hospital, Hines, Ill., on Sept. 17, 1946, after a year's treatment by dilation for stricture of the esophagus. He was unable to swallow solid food and wanted an operation to relieve his distress. The last dilation had been done with a no. 16 bougie.

He gave a history of having swallowed lye while intoxicated in January 1944 when he was absent without leave from his Army unit at Boise, Idaho. Subsequent to this episode he was hospitalized in an Army hospital for one month, after which he was honorably discharged. He was under treatment constantly from that time until he died.

His weight on entrance to the hospital was 105 pounds (47.6 Kg.). Esophagoscopy showed a stricture 27 cm. from the teeth which would admit a size 14 bougie.

After three months of weekly instrumentation, studies made after the administration of barium showed obstruction in the esophagus at the level of the aortic arch. The esophagus above the constriction was increased in diameter. None of the thin opaque material was seen to pass through the area of constriction during fluoroscopic examination. The extent of the constriction below the clavicular level could not be determined.

Esophagectomy was performed on Dec. 18, 1946. From about 4 inches (10 cm.) above the diaphragm the esophagus was found to be thickened, fibrotic and densely adherent to surrounding structures to a point well above the aortic arch. Anastomosis between the antrum of the stomach and the stump of the esophagus was made about 1 inch (2.5 cm.) above this point. A Levine tube was passed through the anastomotic stoma, and its tip was directed through the pylorus. Two hundred thousand units of penicillin was instilled through the catheter placed through the thoracic wall, and the lung was reexpanded after the thorax was closed.

Gross and microscopic examination showed that the pathologic changes in the resected esophagus were similar to those described in case 1.

Electrocardiograms taken before and after operation were normal.

The postoperative course progressed uneventfully until the third postoperative day, when dyspnea and elevation of temperature occurred. A roentgenogram of the chest taken at that time showed minimal infiltration of the right lung at the base. Therapy with penicillin and oxygen was continued, but in spite of this the clinical and roentgenologic symptoms of an extensive bronchopneumonia developed throughout the right lung and atelectasis and accumulation of fluid occurred on the left side. On thoracentesis, 850 cc. of bloody fluid was aspirated. Blood transfusions and other supportive therapy failed. Death occurred on December 24, six days after operation, and an autopsy was performed.

The anatomic diagnosis was as follows: (1) postoperative esophageal stricture; (2) atelectasis of the left lung, with hydrohemothorax; (3) atrophy of the testicles; (4) edema of the right lung, with bronchopneumonia; (5) esophageal resection, with esophagogastrostomy, and (6) surgical resection of the eighth left rib.

The remaining observations made at autopsy were not especially interesting except for those relating to the gastrointestinal tract, which are included here to indicate anatomic changes produced by the operation: The esophagus had been resected from about the level of the aortic arch down to the cardiac end of the stomach. There was evidence of an esophagogastrostomy. There was no evidence of leakage at the suture line. It seemed to have healed cleanly. The cardiac end of the stomach also had been sutured, and this had also healed without evidence of leakage. The entire stomach was lying in the left thoracic cavity alongside the descending aorta. There were few adhesions between it and the mediastinum. The first part of the duodenum was lying through an artificial opening in the diaphragm. This incision was about 4 to 5 inches (10 to 12 cm.) long, had been sutured and had healed firmly. However, where the duodenum passed through the opening there was still enough space to admit the little finger, and part of the omentum had become attached to it. The pylorus was lying about 3 to 4 cm. below the opening in the diaphragm. There was no herniation through this hole. The duodenum had been somewhat straightened, but there was no evidence of strain or pressure on the common bile duct or on the portal vein. The stomach and duodenum were then opened, and no pathologic changes were seen. There was no evidence of leakage from the gastrointestinal tract. The remainder of the small bowel and large colon was essentially normal.

Case 4.—E. A. S., a 21 year old white textile worker, is receiving compensation for a "psychopathic personality" connected with his service in the army. In January 1944, while in the stockade after being absent without leave for the fifth time, he attempted suicide by drinking water in which he had dissolved two handfuls of potash. He was hospitalized at a station hospital, where bronchopneumonia developed, after which he was transferred to Lawson General Hospital

in Atlanta, Ga. Dilations were carried out there for stricture of the esophagus. Transfer to Kennedy General Hospital, Memphis, Tenn., was recommended, and there gastrostomy was performed and retrograde dilation carried out. The patient was separated from the service and was transferred to the Veterans Administration Hospital, Hines, Ill., in September 1944. After three weeks he was discharged. At home he again found that he could not swallow. Unsuccessful at passing a no. 20 bougie which he possessed, he called in a local physician to dilate his esophagus. He was maintained thereafter on periodic dilations and a modified liquid diet until Aug. 23, 1946, when he was readmitted to the Veterans Administration Hospital at Augusta, Ga. After dilations with a no. 24 bougie, his ability to swallow more than a liquid diet did not return, and he was then transferred to the

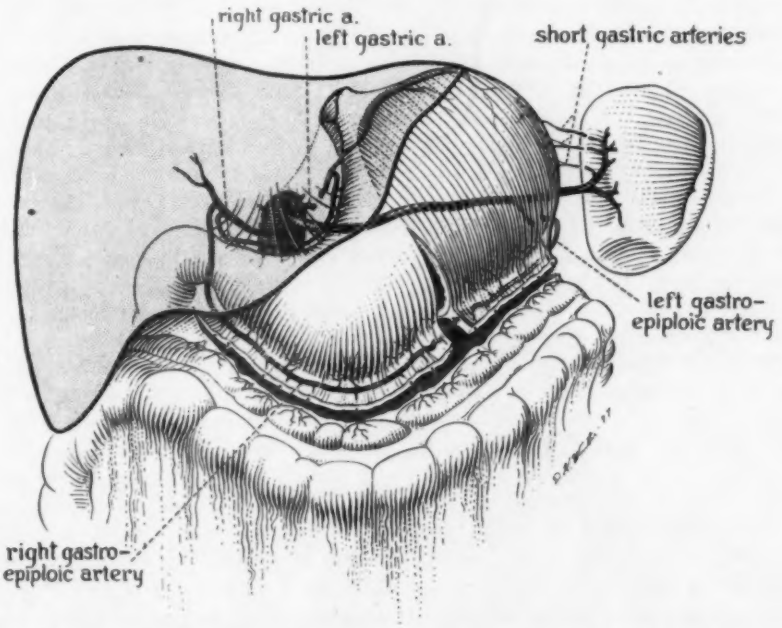

Fig. 5.—Anatomic sketch of stomach showing its normal blood supply and the necessary points of division of the left gastric, left gastroepiploic and short gastric arteries. This drawing also illustrates ligation of the right gastroepiploic artery in conjunction with a previous gastrostomy in case 4 leading to inadequate supply of blood to the proximal portion of the stomach.

Veterans Administration Hospital, Hines, Ill., on Oct. 14, 1946, for further treatment.

Esophagoscopic examination revealed crescentic and vertical strictures at 25 cm. and 28 cm. from the teeth, and studies after the administration of barium showed extreme narrowing of the lumen from the level of the clavicle down to the cardia.

Repeated weekly dilation did not improve the patient's ability to swallow more than a liquid diet. Resection of the esophagus was recommended, and this was accomplished on Jan. 20, 1947.

In this instance the seventh rib was removed and the sixth and fifth ribs were cut in order to give better exposure for making the anastomosis. Dense adhesions were found around the arch of the aorta. The gastrostomy had been made pre-

viously from the greater curvature in such a way as to divide the right gastroepiploic artery and to diminish greatly the blood supply of the proximal portion of the stomach after adequate mobilization of that organ (fig. 5). The esophagogastric anastomosis was performed about 4 cm. above the aortic arch. It was noted that the stomach appeared to be more cyanotic in this patient than in any of the previous patients operated on.

The postoperative course was stormy. The patient was uncooperative from the start. He pulled out the stomach tube several times during the first two days. The tube for pleural drainage became plugged, and 900 cc. of fluid was aspirated from the left pleural cavity on the fourth day and 950 cc. on the fifth day. On the fifth day severe pain developed in the right side of the chest and a roentgenogram showed the presence of bronchopneumonia. The fluid in the left side of the chest became pocketed, and repeated aspirations yielded only a small amount at a time. It then became grossly purulent. A large abscess developed at the site of the gastrostomy. This was drained, and the cavity was found to communicate with the mediastinum and the pleural cavity. Two weeks after operation gastric secretions were obtained at the opening in the chest, and methylene blue injected through a Levine tube in the stomach promptly appeared on the dressings over the wound in the chest. Studies revealed leakage at the gastroesophageal anastomosis, evidently resulting from poor healing due to the impaired blood supply. The patient's temperature at this time was 104 F., and he was becoming extremely weak. Bacteriologic examination of the material obtained from the chest revealed Escherichia coli, Staphylococcus aureus (hemolytic), Streptococcus viridans and Aerobacter aerogenes. Nine units of streptomycin per cubic centimeter was found to inhibit the growth of the organisms recovered. The suction apparatus in the left pleural cavity yielded about 500 cc. of mixed pleural and gastric contents daily. A Rawson-Abbott tube was then passed, and a high protein, high carbohydrate, liquid feeding by the drip method was begun at the same time that gastric suction of the thoracic stomach was being maintained. The patient was given blood transfusions, and he received streptomycin daily. From that time improvement has been progressive. Resistance of the organisms to streptomycin developed to the point that 600 units per cubic centimeter of body fluid did not inhibit their growth, and the use of streptomycin was discontinued after fifteen days.

At the present time the patient's temperature, pulse and respiratory rate are normal. There is no drainage from his chest. There is still a small amount of drainage at the former site of gastrostomy. The Rawson-Abbott tube has been removed, and the patient is eating a regular diet. It appears that the gastropleural fistula has healed spontaneously. The patient is out of bed daily and is gaining weight.

COMMENT

Resection of the esophagus at all levels is becoming practicable. As more and more of these procedures are being reported, the importance of certain factors is being recognized. The relative inaccessibility of the esophagus, its lack of mobility and its close relationship to vital organs make radical resection still a somewhat dangerous procedure. Careful atraumatic technic is important here as it is elsewhere in the body. The retractability of the mobilized esophageal wall, its poor blood supply and consequent poor healing qualities and the high virulence of the organisms in its lumen predispose to leakage at the site of

anastomosis. The resulting medical complications may be serious, as occurred in the last case reported. It is most important to preserve viability in the mobilized stomach by the least possible interference with the vascular anastomoses in its wall. Preliminary gastrostomies, especially of the Beck-Jianu type made from the greater curvature, which interfere with the supply of blood to the stomach create a hazard for successful esophagogastric anastomoses performed high in the chest.

Experience has shown that the mediastinal pleura should be left open to drain in order to minimize the danger of postoperative mediastinitis. Pleural effusion will result in every case, and for that reason a large bore catheter should be placed into the pleural cavity for use in a closed drainage system at least for the first forty-eight hours. To this catheter we attach a Stedman pump with a bottle trap to maintain approximately normal intrapleural negative pressures for as long a time as fluid continues to accumulate in the left side of the chest.

Healing at the site of anastomosis should be given every opportunity to occur. Immobilization of this segment of the gastrointestinal tract is therefore important. This cannot be accomplished by allowing early feeding by mouth postoperatively. Experience with our last patient has indicated the usefulness of the Rawson-Abbott tube in esophageal resection. It keeps the thoracic stomach deflated, allows for early alimentation and provides for immobilization of the anastomotic site for as long as is necessary for good union of the tissues to take place.

SUMMARY

Resection of the esophagus for stricture, with esophagogastric anastomosis high in the chest, is becoming practicable, largely as the result of progress in anesthesiology and in the use of antibiotics and also as the result of experience gained in the use of this procedure in the treatment of carcinoma of the esophagus.

Four cases in which persistent stricture was treated by resection and anastomosis are presented.

Technic, pitfalls and postoperative complications and their treatment are discussed.

Although this procedure may carry with it a higher mortality than more conservative methods of therapy, the end result makes it justifiable as it restores the patient's normal eating habits and frequently overcomes preexisting abnormal psychic states. Intensive preoperative and postoperative care is essential for a successful outcome.

SURGICAL MANAGEMENT OF IRREDUCIBLE INTUSSUSCEPTION

CHARLES W. McLAUGHLIN Jr., M.D.
OMAHA

INTUSSUSCEPTION is second in frequency only to appendicitis as a cause of acute conditions within the abdomen requiring surgical treatment in infancy and childhood. Although recognized since the time of Hippocrates as a pathologic entity, it still often presents a difficult diagnostic problem. Late cases in which the intussusception is found to be irreducible at operation are among the most trying ones encountered in the surgical treatment of conditions occurring in infancy and childhood.

A study of seven published reports on cases of intussusceptions, involving from 55 to 400 patients in each group, indicates that the intussusception was surgically irreducible in 12.4 per cent of the entire group.[1] In the present small series of 21 patients the intussusception was irreducible in 2, or 9.9 per cent, at operation.

Read at the fourth annual meeting of the Central Surgical Association, Chicago, Feb. 22, 1947.

1. (*a*) Clubbe, C. P. B.: The Diagnosis and Treatment of Intussusception, Edinburgh, Y. J. Pentland, 1907. Koch, A., and Oerum, H. P. T.: Intussusception in Children: Four Hundred Danish Cases, Edinburgh M. J. **9**:227-241, 1912. Dowd, C. N.: Resection of One-Third of Colon for Irreducible Intussusception in an Infant Five Days Old, Ann. Surg. **57**:713-718, 1913. (*b*) Eccles, W. M., and Laidlaw, F. F.: An Analysis of a Fourth Series of Eighty-Nine Cases of Intussusception, St. Barth. Hosp. Rep. (1911) **47**:97-130, 1912; cited by Dowd.[1a] Laycock, H. T.: Irreducible Intussusception in a Baby, Treated by Resection: Recovery, Brit. M. J. **1**:120, 1941. (*c*) Perrin, W. S., and Lindsay, E. C.: Intussusception; A Monograph Based on Four Hundred Cases, Brit. J. Surg. **9**:46-71, 1921-1922. (*d*) Ladd, W. E., and Gross R. E.: Intussusception in Infancy and Childhood, Arch. Surg. **29**:365-384 (Sept.) 1934. (*e*) Mayo, C. W., and Woodruff, R.: Acute Intussusception, ibid. **43**:583-587 (Oct.) 1941. Goldman, L., and Elman, R.: Spontaneous Reduction of Acute Intussusception in Children: Its Incidence and Significance in Diagnosis and Treatment of Recurrent Intussusception, Am. J. Surg. **49**:259-263, 1940. (*f*) Kahle, H. R.: An Analysis of One Hundred and Fifty-One Cases of Intussusception from Charity Hospital of Louisiana at New Orleans, Am. J. Surg. **52**:215-225, 1941. (*g*) Gibbs, E. W., and Sutton, P. W.: Intussusception—Ninety-Two Cases in Infancy and Childhood, Surgery **14**:708-718, 1943.

The principal factors which contribute to the frequency of irreducibility are (1) delay in diagnosis and corrective operation, (2) location of the intussusception and (3) multiple intussusceptions.

The first factor requires no discussion since its role is well appreciated. The relative frequency of the various anatomic types of intussusception has been listed as follows[2]: (*a*) enteric (ileoileal), 10 to 15 per cent; (*b*) colic, 5 to 10 per cent; (*c*) enterocolic (all forms), 75 to 80 per cent.

From a review of the reported instances of irreducible intussusceptions, an unusually high percentage are found to be of the enteric type.[3] Elliott-Smith[4] has pointed out that this type of intussusception begins and progresses slowly, producing mild symptoms at first. An abdominal mass is infrequently palpable, and the delay in surgical intervention often results in the finding of a tight or gangrenous sheath requiring radical treatment. Perrin and Lindsay[1e] observed that "the type of intussusception with the milder symptoms is ultimately the most fatal." The mortality as influenced by the area of bowel involved is listed by two authors as follows.

Gibbs and Sutton	92 cases	Perrin and Lindsay	400 cases
Enteric	62.5%	Enteric (15 of 27 cases)	55%
Ileoileocolic	44.4%	Ileocecal	32%
Ileocolic	25.4%	Ileocolic	30%
Colic	25%	Colic	15.7%

The presence of multiple intussusceptions also contributes to the incidence of irreducibility. Ladd and Gross[1d] observed these in 3 of their 372 cases and Kahle[1f] in 3 cases in his series of 151. Numerous other reports are noted of multiple intussusceptions requiring radical surgical intervention because of irreducibility.[5]

Today it is generally conceded that surgical reduction is the ideal therapeutic procedure for intussusception as soon as this diagnosis is

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2. Williams, E. B.: Intussusception: A Radiological Study, Brit. J. Radiol. **13**:51-70, 1940.

3. (*a*) Stuppel, R.: Treatment of Irreducible Intussusception Due to Meckel's Diverticulum, Brit. M. J. **2**:722-723, 1939. (*b*) Greenberg, M.: A Case of Double Intussusception, ibid. **2**:448-449, 1939. (*c*) Forty, F.: Enteric Intussusception Treated by Resection, Lancet **1**:72-73, 1940.

4. Elliott-Smith, A.: Irreducible Intussusception: A Report of Four Cases, Lancet **2**:992-994, 1935.

5. Fallis, L. S., and Warren, K. W.: Irreducible Intussusception in Infants, Surg., Gynec. & Obst. **81**:384-386, 1945. Hindmarsh, T. A.; Stewart, A. W., and Morrison, B.: The Mikulicz Resection Operation for Gangrenous Intussusception in Infants, Brit. M. J. **2**:382-384, 1945. Clark, C. W.: Irreducible Double Intussusception Due to Meckel's Diverticulum Complicated by Volvulus, Brit. J. Surg. **31**:301-303, 1944. Vellacott, H. F.: Intussusception in a Baby, Treated by Resection: Recovery, Brit. M. J. **1**:72, 1942. Southam, A. H., and Cranshaw, C. H.: Resection of Intestine for Acute Intussusception: Two Cases with Recovery, ibid. **1**:266-267, 1921. Greenberg.[3b] Elliott-Smith.[4]

clinically established. The surgical technic in the usual case has become standardized. When an irreducible intussusception is encountered, the following operative procedures have been employed[6]: (1) resection with end to end or lateral anastomosis; (2) resection with double enterostomy and subsequent closure; (3) lateral anastomosis about the lesion, leaving the intussusception in situ; (4) lateral anastomosis, with exteriorization of the lesion and secondary resection; (5) suture of the serosa of the invaginating bowel and the intussuscipiens, followed by resection of the gangrenous intussusceptum through an incision in the ensheathing bowel; (6) ileostomy with secondary resection, and (7) combinations of these procedures.

Of the various procedures, four have been employed with sufficient frequency to merit discussion (table 1).

Resection with immediate anastomosis, usually of a lateral type, has been the most commonly employed method of dealing with an irreducible

TABLE 1.—*Surgical Procedures in Two Hundred Cases of Irreducible Intussusception from 1907 to 1947 (Ages of Patients, 1 to 12 Years)*

Surgical Procedure	Number of Cases	Number of Deaths	Mortality, per Cent
Resection and anastomosis	146	99	67.8
Maunsell's procedure	8	8	100
Lateral anastomosis	15	4	26.6
Colostomy or Mikulicz operation	31	27	87
	200	138	69

intussusception. Clubbe[1a] in 1907 accomplished the first successful resection of the terminal end of the ileum in an 11 month old infant, this being his first success in a series of nine resections. That the procedure carries a high mortality when done by expert hands is evidenced by the fact that Ladd and Gross[1d] reported only one successful operation, on a 4 year old boy, in sixteen consecutive resections done prior to 1934. A series of 146 cases in which patients were submitted to resection with immediate anastomosis during the last forty years has been collected, with 99 deaths, giving an over-all mortality of 67.8 per cent.

Resection of the gangrenous intussusception, with the formation of a double-barreled enterostomy, has been the second most frequently employed method. In general, this procedure has carried an extremely high mortality, since it subjects the infant or child to the burden of an

6. Capone, A. J.: Acute Intussusception in Infancy, Am. J. Surg. **57**:12-19, 1942. Gordon, E. F.: Intussusception: A Review of Forty-Two Cases from the Files of the New Haven Hospital and Two Cases Seen in Private Practice, Arch. Pediat. **57**:585-594, 1940.

ileostomy, which even for a short period is hazardous. This technic in a series of 31 collected cases resulted in a mortality of 87 per cent and has been employed much less frequently in recent years.

Lateral anastomosis about an irreducible intussusception was first successfully performed by Rutherford [7] in 1909, and in the same year Parry [8] recorded a second successful operation. In only a small number of the recorded cases has the intussusceptum been observed to slough and to be passed through the bowel.[9] The method is obviously only applicable to cases of irreducible intussusception and cannot be employed in the presence of gangrenous bowel. It is feasible in the usual ileocolic type of intussusception, since the colonic sheath of the intussusception usually continues to remain viable, but it should not be employed for an enteric lesion. A series of 15 cases in which the condition was treated by lateral anastomosis has been collected from the literature, with 4 deaths, giving a mortality of 26.6 per cent.

TABLE 2.—*Mortality in Surgical Management of Irreducible Intussusception by Decades*

	1907-1917		1917-1927		1927-1937		1937-1947	
Procedure	Cases	Mortality, %	Cases	Mortality, %	Cases	Mortality, %	Cases	Mortality, %
Resection	32	84	49	77	17	88	48	39
Maunsell's procedure	2	100	..	..	3	100	3	100
Lateral anastomosis	3	33	..	..	5	0	7	43
Colostomy or Mikulicz operation	..	..	6	100	14	93	11	73
Percentage mortality in decades	37	81	55	80	39	79	69	48

The last procedure used with any degree of frequency has been that associated with the name of Jessett, Barker or Maunsell. This entails a longitudinal incision through the outer layer of the intussusceptum to expose the intussuscepted mass, which is then resected close to the neck of the intussusception. The longitudinal incision is then closed, and a few sutures placed at the junction of the entering bowel and the neck of the intussusception complete the procedure. The results with this procedure have been discouraging; 8 recorded cases have been reviewed, with a mortality of 100 per cent.

The 200 cases of irreducible intussusception collected from the literature over a forty year period have been further analyzed in terms of

7. Rutherford, H.: Irreducible Intussusception in the Infant Treated by Ileo-Colic Anastomosis, Brit. J. Child. Dis. **6**:405-410, 1909.

8. Parry, R. H.: The Treatment of Irreducible Intussusception by Lateral Anastomosis, Proc. Roy. Soc. Med. **2**:271-275, 1909.

9. Montgomery, A. H., and Mussil, J. J.: The Treatment of Intussusception in Children, Surg., Gynec. & Obst. **51**:415-420, 1930. Footnotes 4, 5, 6, 7 and 8.

decades to note the trend in the procedures employed and in the attendant mortality (table 2). It is noteworthy that resection with immediate anastomosis is becoming more generally employed as the procedure of choice, with a commendable improvement in the mortality. While the over-all mortality in irreducible intussusception has dropped from 81 to 48 per cent in this forty year period, the mortality from resection with immediate anastomosis has declined from 84 to 39 per cent in the same period.

The greatest number of fatal cases have always involved and will probably continue to involve children under 1 year of age who are seen with irreducible intussusception (table 3). A series of 13 cases in which operation was successful has been compiled, the age and the type of procedure employed having been noted.

TABLE 3.—*Irreducible Intussusception in Children Under One Year of Age Who Recovered After Surgical Intervention*

Author	Year	Cases	Age	Procedure
Collinson	1907	1	3 mo.	Resection—button
Clubbe	1908	1	11 mo.	Resection
Rutherford	1908	1	4 mo.	Lateral anastomosis
Parry	1909	1	6 mo.	Lateral anastomosis
Dowd	1913	1	5 days	Resection
Eisendroth	1915	1	3 mo.	Resection
Southam and Cranshaw	1921	1	6 mo.	Resection (below anus)
Montgomery and Mussil	1930	1	7 mo.	Lateral anastomosis
Greenberg	1939	1	8 mo.	Resection
Fallis and Warren	1945	2	5 and 8 mo.	Resection
Hindmarsh	1945	1	10 mo.	Resection
McLaughlin	1946	1	8 mo.	Resection

In recent months 2 children, aged 5 and 8 months, have been found at operation to have irreducible intussusceptions. The first child, 5 months of age, had an ileocolic lesion, when seen on the third day, which had advanced into the sigmoid colon. Reduction back to the cecum was accomplished with considerable difficulty. The utilization of gentle pressure to reduce edema in this segment resulted in the production of a longitudinal tear in the outer sheath. With the cecum open it was possible to reduce the intussusception after cutting through the constricting ring at its neck. The rent in the cecum was closed, and the terminal end of the ileum and the cecum were exteriorized. This child succumbed two hours after the operation from shock; the autopsy showed trauma of the terminal end of the ileum and of the cecum (fig. 1).

The second child, 8 months of age, was found to have what appeared to be an ileocecal type of lesion. Its irreducibility was apparent at once, and a resection of the terminal end of the ileum and ascending

colon was carried out, a lateral anastomosis being performed. This child made an uneventful recovery (figs. 2, 3 and 4).

Shock and toxemia are the most common causes of death during the postoperative period; in 75 to 80 per cent of all fatal cases the patients succumb to these during the first twenty-four hours after operation.

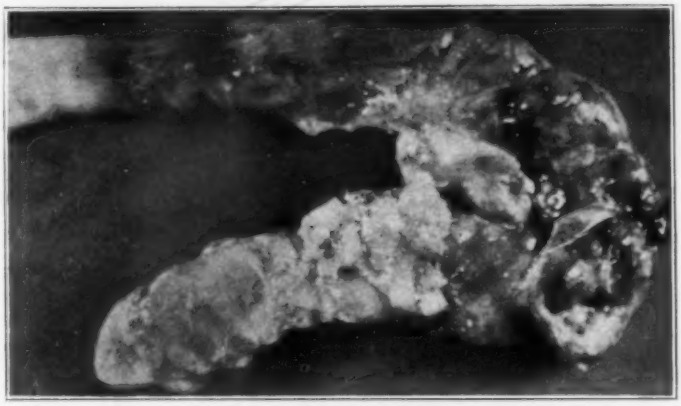

Fig. 1.—Postmortem specimen of reduced ileocolic intussusception (case 1).

Fig. 2.—Surgical specimen of resected terminal end of the ileum and ascending colon containing intussusception (case 2).

Prolonged manipulation and trauma must always be reduced to a minimum in the surgical treatment of infants and children. With improved surgical technic, pediatric after-care and the use of chemotherapy and antibiotics, surgical resection has become a much safer

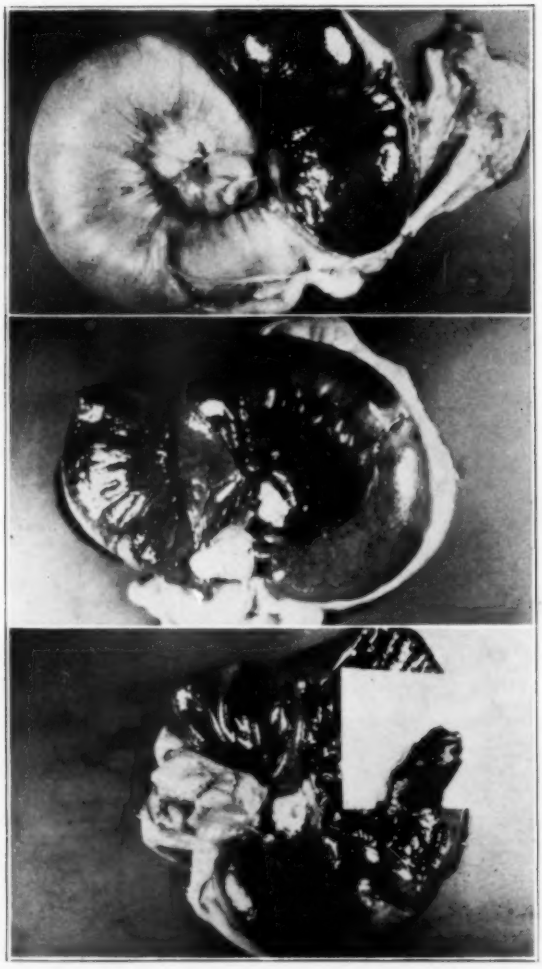

Fig. 3.—Successive steps in dissection of the surgical specimen (case 2), demonstrating this to be a multiple lesion, with a double enteric intussusception and an associated ileocecal extension.

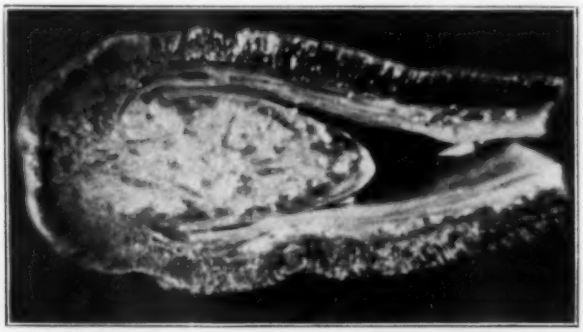

Fig. 4.—Close-up view of the tissue forming the head of the intussusceptum noted in the lowest picture of figure 3. This on section was found to be aberrant pancreatic tissue in the wall of the terminal end of the ileum.

method of handling these irreducible intussusceptions. It is felt that a decision to resect in a given case should be made as promptly as possible after a fair but limited effort at manual reduction has been made and found unsuccessful. Resection after prolonged manipulation and trauma will inevitably mean a high mortality.

SUMMARY

A collected series of 200 infants and children with irreducible intussusception has been reviewed, and 2 additional cases have been reported.

The over-all surgical mortality in this collected group of patients was 69 per cent, but the mortality has dropped from 81 to 48 per cent in the past forty years.

Recovery in children under 1 year of age following surgical therapy of an irreducible intussusception is still unusual; 1 additional case has been reported.

Improved surgical technic, pediatric care and the use of chemotherapy and the antibiotics have made resection the method of choice in handling these problems, with a steadily improving mortality rate

It is urged that a decision as to the necessity of resection be made promptly after limited manipulation and trauma to reduce the attendant shock which is always a postoperative factor.

DISCUSSION

DR. EUGENE A. OSIUS, Detroit: I should like to say a word or two about Dr. McLaughlin's paper on intussusception. In the Children's Hospital in Detroit we have been very much interested in this particular subject. We are in the process of making a survey of cases of intussusception occurring during the past fifteen years, and a few points have come up which are of particular interest. One is that practically all these cases fall into a definite pattern as far as symptomatology or signs are concerned; in fact, you can go from one record to another, and except for change of name you feel you are reading the same record. One of the features of intussusception is that it goes unrecognized too long. It is not given enough publicity, although, as Dr. McLaughlin says, it stands second to appendicitis in abdominal emergencies in children. I should like at this time to make a plea to those of you who do any amount of surgical procedures in children. When you have an opportunity to talk to groups of general practitioners or pediatricians, the subject of intussusception might be selected as your subject a little more frequently. I think the subject needs a little propaganda in order to bring down the mortality rate. We have found that the mortality rate is directly proportional to the length of time from the onset of symptoms until the patient enters the hospital and the operative procedure is carried out.

One other thing that has come to light is that in the first years the mortality was extremely high, at one time reaching 58 per cent. It is interesting to see that as time goes on the mortality has dropped appreciably, which is due not so much to technic as to the physiologic approach, the use of electrolytes and the practice of getting the patient into better condition before operation. The use of anti-

biotics has helped to a limited extent. I believe that when you evaluate any series these factors should be taken into consideration.

I should like to commend Dr. McLaughlin's paper not only for the contribution of a good idea so far as irreducible intussusception is concerned but also for the excellent way in which it was presented and the good résumé of the previous cases in the literature. The photographs were particularly good. I am glad to have heard this paper.

DR. JOHN B. CONDON, Chicago: In a discussion of Dr. McLaughlin's paper I can serve only to emphasize some of the points he has made.

(Slide.) This slide represents an analysis of a series of cases of intussusception at the Children's Hospital of Cook County Hospital, Chicago, extending over a period of twenty-one years, from 1925 to 1946, and shows a total of 99 cases of intussusception for that period.

(Slide.) As far as the factors in the determination of mortality are concerned, my colleagues and I are firmly convinced that the duration of symptoms is extremely important, as this chart will bear out. In the first twenty-four hours 43 patients have had surgical treatment, with 1 death, a mortality rate of 2.3 per cent. With an increase in the duration of symptoms there is a sharp rise in the mortality, with 15.6 per cent over twenty-four hours and under forty-eight hours, and over this is a mortality of 50 per cent.

(Slide.) This is a diagrammatic illustration to show the most frequent location of the intussusception in our series. We cannot agree with those authors who hold that the location or the distal progression of the mass is in direct relation to the mortality. The mortality rate for intussusception in the left lower quadrant was considerably lower than that for intussusception in the epigastrium. Also, to show that the duration of symptoms has little relation to the distal progression of the mass we have noted that the average duration of symptoms for masses in the epigastrium was twenty-seven hours, while for those in the left lower quadrant it was twenty-five.

(Slide.) The last slide shows the results obtained in cases of irreducible intussusception. In this series, numbering 14 persons, 8 recovered and 6 died, an over-all mortality of 42.8 per cent. I feel that we are at the same disadvantage as many other authors as far as analyzing this problem is concerned. There were really not enough cases to draw any definite conclusions.

In our analysis of the mortality factors in intussusception, the prolonged period of symptoms is the foremost and bears the strongest influence on the mortality rate. Continued vigilance on the part of the pediatrician and the surgeon, with early diagnosis and surgical treatment, should be the aim of all concerned with this problem.

DR. EDWIN M. MILLER, Chicago: I would say that Dr. McLaughlin's subject, i.e., irreducible intussusception, always presents major problems. In my personal experience with sixty-nine acute intussusceptions for which I have operated fourteen, or 20 per cent, were irreducible and all but one required resection. In this group there were 6 recoveries and 8 deaths—a mortality rate of 57 per cent. One of the most dramatic of the successful results is represented in these kodachrome slides of a 3 month old Negro baby in whom the intussusception had begun in the lower part of the ileum, had passed through the entire colon and could be palpated with the finger in the rectum. Under local anesthesia 10 inches (25 cm.) of the terminal end of the ileum and all of the colon as far down as the lower part of the

sigmoid was resected, leaving a double-barreled opening to the outside. The films illustrate the appearance before and after closure of the bowel and the final result. The type of operation in these desperate cases depends entirely on the patient's condition. Occasionally a resection and anastomosis can be made, and often a lateral anastomosis can be combined with an exteriorization, but most times one is lucky to be able to perform only an exteriorization.

DR. EDWIN VARY, Flint, Mich.: I should like to add 3 cases to Dr. McLaughlin's cases of irreducible intussusception: In 2 of these the operations were done by the man who preceded me in my surgical partnership. I did not know him personally, but he left excellent records. His 2 cases occurred many years ago before much was known about fluids. He simply used tacking with linen sutures at the junction of the intussusception. Of the 2 patients, 1 lived and made an uneventful recovery. I had 1 case in the same category. However, I did not have the courage just to tack the intussusception but also did an ileotransverse colostomy. Nothing was passed by rectum. I was able to follow the case for a period of eight months.

CONGENITAL DUODENAL OBSTRUCTION (INTRINSIC OBSTRUCTION)

CLIFFORD D. BENSON, M.D.
AND
GROVER C. PENBERTHY, M.D.
DETROIT

CONGENITAL atresia and stenosis of the intestinal tract of infants have been associated with a high mortality rate. In 1922 Davis and Poynter [1] collected 392 cases. The mortality was 100 per cent for congenital occlusive lesions of the intestines between the pylorus and the rectum. It has been estimated that the condition occurs in about 1 in 20,000 infants.

In this discussion we are confining ourselves to a consideration of intrinsic congenital obstructive lesions of the duodenum. Calder in 1733 described the first case of atresia of the duodenum. During the past quarter century, with better diagnosis and surgical treatment, the mortality has been reduced. Through the surgical efforts of Ladd,[2] Donovan, Miller,[3] Horsley,[4] Trusedale and others,[5] approximately thirty successful operative recoveries have been recorded. Early surgical intervention is not always as urgent in stenosis of the duodenum and partial obstruction as in atresia.

The early recognition of duodenal atresia in the first few days of the newborn infant is of paramount importance. Vomiting usually

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Read at the fourth annual meeting of the Central Surgical Association, Chicago, Feb. 22, 1947.

1. Davis, D. L., and Poynter, C. W. M.: Congenital Occlusions of the Intestines, Surg., Gynec. & Obst. **34**:35, 1922.

2. Ladd, W. E., and Gross, R. E.: Abdominal Surgery of Infancy and Childhood, Philadelphia, W. B. Saunders Company, 1941. Ladd, W. E., in discussion on Miller.[3]

3. Miller, E. M.: Bowel Obstruction in the Newborn, Ann. Surg. **110**:587, 1939.

4. Horsley, J., in discussion on Miller.[3]

5. Leitch, P.: Duodenal Atresia in Newborn Infant, Brit. M. J. **2**:885, 1945. Sumner, W. C., and Morris, K. A.: Duodenal Atresia in Newborn: Case Report, Am. J. Surg. **68**:120, 1945.

occurs on the first day after feeding and is persistent and bile-stained if the obstruction is at or below the ampulla of Vater. Simultaneously, peristaltic waves are noted in the epigastrium, often passing to the right and downward. Dehydration is progressive, with repeated vomiting. A roentgenogram of the abdomen in the upright and inverted positions, without the ingestion of barium, will reveal the gaseous distention of the stomach or duodenum or both. Failure to find gas shadows in the small and large bowels is of further importance in localizing the obstruction.

Infants with atresia or stenosis will require immediate correction of their dehydration and chemical imbalance. A short-circuiting procedure

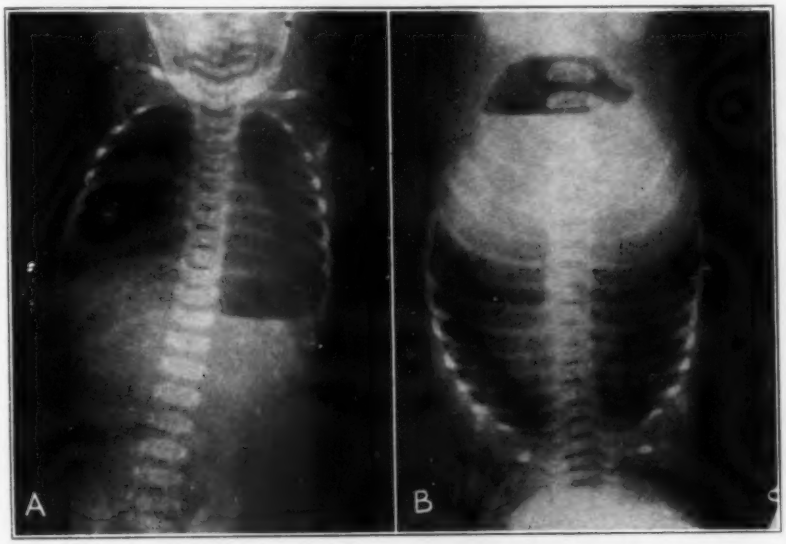

Fig. 1.—*A*, flat plate roentgenogram of abdomen showing gaseous distention of stomach; *B*, roentgenogram taken with the infant in the inverted position, showing gaseous distention of the stomach and duodenum.

is necessary for their survival. The procedure of choice for an obstruction at or below the ampulla of Vater is gastroenterostomy or duodenojejunostomy. The latter is preferred by most surgeons who have had experience with the lesion because, as emphasized by Ladd, duodenojejunostomy drains the duodenum better and it prevents neutralization of the acid secretion of the stomach and consequent loss of appetite. The performance of duodenojejunostomy is not without difficulty. It is not always preferable because it may be technically difficult to anastomose a greatly dilated viscus to a small jejunum which has not functioned. Two cases of duodenal atresia are presented.

CASE 1.—G. K., a white male infant 3 days old, was admitted to the Children's Hospital on March 13, 1941. He had been vomiting bile-stained fluid since the first day of life. Dehydration was severe, and slight jaundice was present. The abdomen was not distended. A roentgenogram of the abdomen in the upright position revealed considerable gaseous distention of the stomach. No gas was visualized in the small or the large bowel. After correction of dehydration, laparotomy was performed on March 14. The stomach and the first portion of the duodenum were greatly dilated. A gastroenterostomy was performed posteriorly by the two layer method. The postoperative course was satisfactory for the first week. The patient had stools containing bile. In the next four days

Fig. 2.—Roentgenogram made on twelfth day after posterior gastroenterostomy. The barium at the end of four hours has passed into the small bowel, with some still retained in the stomach.

vomiting became persistent, and it was evident that the stoma was not functioning. The condition was so poor that reoperation was not considered feasible, and the patient died of complicating pneumonia and malnutrition one month after operation. Postmortem examination revealed notable dilatation of the stomach. The first part of the duodenum was distended and gave the appearance of a continuation of the stomach itself. The greatly dilated duodenum was adherent to the liver and ended as a blind pouch beyond the entrance to the ampulla of Vater. No remnant of a lumen could be made out. About 6 mm. beyond the end of the blind pouch the duodenum had a uniform lumen, but it continued in a collapsed state to the

first part of the jejunum. The gastroenterostomy stoma was contracted. As the stomach contracted, the stoma apparently functioned poorly. Examination of the lungs revealed an extensive bilateral bronchopneumonia.

CASE 2.—A. B., a Negro female infant 4 days old, was admitted to the Children's Hospital on Aug. 31, 1946. The birth weight was 8 pounds (3.6 Kg.). There had been vomiting of bile-stained fluid since the first day of life. Dehydration was moderate, and there had been a loss of 1 pound and 6 ounces (0.6 Kg.) in weight. Peristaltic waves were noted in the epigastrium.

The infant was prepared for operation by the administration of 400 cc. of a 10 per cent solution of dextrose in equal parts of water and isotonic solution of sodium chloride. Laparotomy was performed the evening of the day of admission

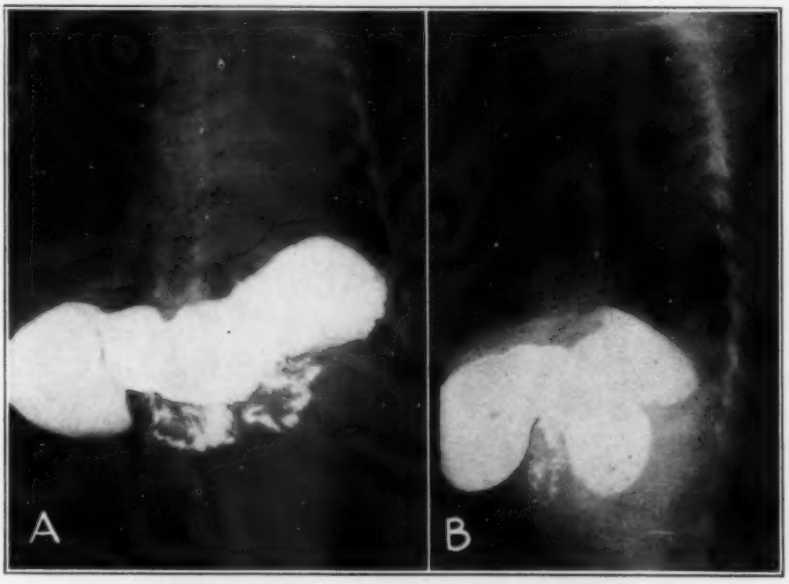

Fig. 3.—*A*, barium-filled stomach and duodenum. The latter shows gross dilatation to its third part. *B*, lateral roentgenogram showing notable gross dilatation of the duodenum.

to the hospital with the patient under ether anesthesia. The abdomen was opened through a right rectus incision. Exploration revealed pronounced distention of the stomach and duodenum as far as the retroperitoneal portion. A gastroenterostomy was performed posteriorly without clamps, silk 00000 sutures being used in two layers. Postoperatively, suction gastric drainage was continued for forty-eight hours and fluids given intravenously. On the third postoperative day the formula used after the Fredet-Ramstedt procedure for pyloric stenosis was given and retained. The patient continued to retain all feedings and the operative wound healed per primam. She was discharged from the hospital on the thirteenth postoperative day.

She continued to develop normally, and now, at the age of 5 months, her weight is 13 pounds (6 Kg.).

In stenosis or in partial duodenal obstruction an emergency procedure is not always an urgent requirement. The following case illustrates this type of lesion and its surgical management.

CASE 3.—F. K. was a 24 month old white male infant weighing 21 pounds (9.5 Kg.). He had vomited repeatedly since birth, and the fluid on occasion was bile stained. He had been unable to retain solid food, so his diet had been restricted to fluids. Preoperative gastrointestinal roentgenograms are shown in figure 3.

Fig. 4.—Roentgenogram made on fourteenth day after duodenojejunostomy shows that the barium after four hours has progressed to the transverse colon, with a minimal gastric residue.

The roentgenograms demonstrated gross dilatation of the first and second segments of the duodenum. The obstruction in the third segment was incomplete, the hourly roentgenograms showing a small amount of barium passing beyond the obstruction and into the small bowel. At twenty-four hours a small amount of barium was still retained within the upper gastrointestinal tract, apparently proximal to the duodenal obstruction.

On May 4, 1946, with the patient under ether anesthesia, the abdomen was opened through a right rectus incision. The stomach and duodenum were moder-

ately dilated to the retroperitoneal portion of the latter. An anticolic duodenojejunostomy was performed, sutures of size 00000 silk and 00000 surgical gut being used in three layers. The postoperative course was uneventful, and solid food was retained. On May 18 study of the gastrointestinal tract was done.

The patient was discharged from the hospital on the fourteenth postoperative day. Nine months have passed since the gastroduodenostomy was performed, and the patient has continued to gain weight and to tolerate a regular diet without difficulty.

SUMMARY

Two cases of duodenal atresia at or below the ampulla of Vater have been presented. One patient, an infant 4 days old, survived after a posterior gastroenterostomy and has remained well.

One patient with duodenal stenosis, 24 months old, responded satisfactorily to a duodenojejunostomy and has remained well.

The early recognition and operative correction of these anomalies are emphasized.

DISCUSSION

Dr. Robert M. Wansbrough, Toronto, Canada: If I may say a word about Dr. Benson's case, my colleagues and I see a considerable number of cases in which there is obstruction in the duodenum, and in several the condition has continued until the patient, probably weighing from 14 to 17 pounds (6 to 7 Kg.), was 2 years of age. A great number of patients have some failure of rotation, and it is not uncommon to find the cecum and the appendix in the epigastrium or to the left of the midline. There is one thing that we have fairly definitely decided, i. e., if a duodenojejunostomy is done one should not try to free the bowel too much. Do the anastomosis and do not persist in the attempt to remove some adhesions. The anastomosis relieves the obstruction due to congenital malrotation.

Dr. Grover D. Penberthy, Detroit: It is estimated that in 30 per cent of cases atresia or stenosis occurs in the duodenum, while in the remaining percentage it occurs in the rest of the intestinal tract, most commonly the rectum. From pathologic examination atresias may be found to be multiple whereas the stenosis is a single lesion.

Common to all atresias, vomiting usually begins within the first twenty-four hours, whereas vomiting in atresias lower down in the intestinal tract begins at a later hour. As a preliminary study the flat plate roentgenogram, taken in the upright, lateral and inverted positions, will give sufficient information to aid in the localization of the atresia. Administration of barium to a child suspected of having a complete atresia of the upper intestinal tract is not without danger.

In Dr. Benson's presentation he has referred to 2 cases of atresia and 1 of stenosis, and he has mentioned the fact that the treatment of the atresia is always an emergency, whereas with stenosis in which the lumen is sufficiently patent to allow some fluid to pass more time can be used in evaluating the lesion with the aid of barium studies for exact localization, as shown by his slides. It is our

experience that it is sometimes difficult to determine anatomically where the duodenum begins and the stomach ends. Furthermore, the inexperienced surgeon dealing with this condition will be surprised to see the small caliber of the jejunum and colon. This is because gas has not entered these parts, making the surgical anastomosis extremely difficult. This type of operation requires the use of small instruments, eye needles and silk and chromic catgut 00000 sutures. Minimal trauma is paramount.

MECKEL'S DIVERTICULUM AS AN ACUTE SURGICAL EMERGENCY

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IN 1815 Meckel described an anomaly of the distal ileum in the form of a diverticulum that occurred in the terminal 30 inches (76 cm.) of the ileum. From that time, this congenital anomaly has been known as Meckel's diverticulum and has been reported by pathologists as having been found in from 2 to 4 per cent of all patients on whom autopsy is performed. A large number of persons probably live their normal span of life with a Meckel diverticulum and at no time have any definite symptoms referable to the condition. In others, the diverticulum may be observed as an incidental finding during an operation for some other condition, such as routine pelvic laparotomy or interval appendectomy. On the other hand, Meckel's diverticulum may make its presence known in a dramatic manner in the first few months or the first few years of life, or it may not manifest itself until many years later.

There are other surgical conditions which may occur as a result of persistence of remnants of the yoke sac and omphalmomesenteric vessels, such as fecal fistulas through the umbilicus, omphalmomesenteric cysts and the like. However, a discussion of these conditions is not within the scope of this paper.

HISTOLOGIC CHANGES

The tissues found in a Meckel diverticulum can and do cover a wide range. A small percentage may contain only ileal mucosa, but the larger percentage will contain gastric mucosa. There is usually a well defined line of demarcation between the gastric and the ileal mucosa, and occasionally the ulceration that precipitates hemorrhage will appear at this junction, being much akin to the stomal ulcer at the site of a gastrojejunostomy. The diverticulum in 1 case of the group collected contained typical jejunal mucosa. There were 2

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From the University of Louisville School of Medicine and the Surgical Departments of Louisville General Hospital and the Children's Free Hospital.

cases in which the diverticulum contained, in addition to gastric mucosa, pancreatic tissue. At the time of the operation in these cases the pancreatic tissue appeared as a firm, elastic, nodular area in the wall of the diverticulum. Such an area might lead the surgeon to suspect that some neoplastic change had taken place therein.

The case reports presented contain examples of complications that may arise because of the presence of a Meckel diverticulum and are presented as cases that have come to my attention either privately or in consultation at the Surgical Service of the Children's Free Hospital and the Pediatric Service of the Louisville General Hospital.

MECKEL'S DIVERTICULUM AS AN INCIDENTAL FINDING

Every surgeon has had the experience of finding a Meckel diverticulum at the time of an exploration for some other intra-abdominal condition. Any time a surgeon opens an abdomen and explores the lower quadrants for any pathologic changes, except in the presence of acute infection, he should examine the terminal 25 to 30 inches (63 to 76 cm.) of the ileum and look for a Meckel diverticulum.

ACUTE DIVERTICULITIS

The incidence of acutely inflamed Meckel's diverticulum is relatively low. In most cases the opening of the diverticulum into the ileum is so large in comparison to the remainder of the diverticulum that occlusion of the opening is almost impossible; however, there may be a rare case in which torsion of the base of the diverticulum has occurred and has caused occlusion of the opening, with resultant gangrene.

The diagnosis of an acutely inflamed diverticulum may be difficult because of the possibility of the diverticulum being in any of the four major quadrants. It is true that the pain and tenderness in most of the cases of acute diverticulitis are in the right lower quadrant or in the midline. In most cases of acute diverticulitis the preoperative diagnosis of acute appendicitis is made. A history of gradually increasing abdominal pain, followed by nausea, vomiting, fever, leukocytosis and localized tenderness should bring the possibility of an acute Meckel diverticulum to the mind of the pediatrician or surgeon, particularly if the area of point tenderness and muscle spasm is not in the so-called usual location, i. e., McBurney's point. In cases in which a preoperative diagnosis of acute appendicitis has been made and in which at operation the gross appearance of the appendix is not in line with the clinical picture, search for a diverticulum should always be made. Care should be taken to inspect at least 30 inches (76 cm.) of the terminal end of the ileum.

CASE 1.—S. L. N., a female infant aged 9 months, was admitted to the hospital with the history that about eighteen hours prior to the time of admission she had

apparently begun to have abdominal pain, as evidenced by the fact that she grasped the abdomen and flexed her thighs. Shortly after this she began to regurgitate part of her formula.

Examination revealed a well developed female infant of 9 months who seemed moderately ill. The head, neck, heart and lungs were clinically normal. Examination of the abdomen revealed apparent tenderness throughout the lower part, which was more severe in the midline just below the umbilicus.

A preoperative diagnosis of acute appendicitis was made, and the abdomen was explored through a right rectus incision. An acutely inflamed Meckel diverticulum was found approximately 20 cm. proximal to the ileocecal valve. The diverticulum was resected, and the abdomen closed in layers. The patient made an uneventful recovery.

Case 2.—C. L. H., a boy aged 14, was admitted to the hospital with the chief complaint of pain in the abdomen. The onset of the pain had been about six hours prior to his admission and had begun as a generalized abdominal soreness that had gradually become localized in the right lower quadrant. There had been nausea but no vomiting. The stools had been normal, and the last bowel movement had been the day prior to his admission to the hospital. There had been no previous episodes of this nature. The remainder of the past history was essentially noncontributory.

Physical examination revealed a temperature of 100.4 F., a pulse rate of 100 and a respiratory rate of 20. The patient was a well developed, well nourished white boy who was moderately ill. Examination of the head, neck, heart and lungs showed them to be normal. Examination of the abdomen revealed generalized tenderness throughout, the area most severely affected being the right lower quadrant. There was no definite muscular spasm or rigidity. Rebound tenderness and pain referred to the right lower quadrant were present. Rectal examination disclosed generalized tenderness throughout. No masses were made out. Laboratory examination showed a white blood cell count of 17,600, with 89 per cent polymorphonuclear cells.

A preoperative diagnosis of acute appendicitis was made. With the patient under spinal anesthesia the abdomen was opened through a right transverse incision placed just above the level of the anterior superior iliac spine. On entrance to the abdomen there was a moderate amount of milky fluid encountered. The appendix was visualized and found to be essentially normal except for evidence of periappendicitis. The terminal end of the ileum was then inspected, and 24 inches (61 cm.) from the ileocecal valve an acutely inflamed Meckel diverticulum was found. The diverticulum was removed after the manner described elsewhere in this paper and the abdomen closed in layers with interrupted silk sutures. The patient made an uneventful recovery.

ACUTE HEMORRHAGE

In a number of cases of intestinal hemorrhage in children the diagnosis may not be obvious. Bleeding from an ulcer in Meckel's diverticulum or bleeding from multiple pinpoint hemorrhagic spots in a diverticulum may manifest itself as an occasional tarry stool or may present the other extreme in the form of copious stools of bright red blood passed frequently and the presence of borderline or actual shock. When there is only a minimal ulceration and a minimal amount of bleeding, with the passage of an occasional tarry or dark brown stool

and with no other presenting complaints, the diagnosis may be difficult. A barium enema and double contrast enemas will help rule out the diagnosis of single or multiple polypi in the colon but will not demonstrate a Meckel diverticulum. Occasionally, roentgenograms taken at hourly intervals after a fractional barium meal with a small amount of thick barium may, in ideal circumstances, demonstrate a Meckel diverticulum. In the presence of an original massive hemorrhage in a child the diagnosis of a bleeding Meckel diverticulum is presumptive.

In the greatest percentage of cases of acute massive hemorrhage the patient will have had no previous intestinal disorders, will complain of a repeated desire to defecate and will pass a moderate to large amount of bright red to brown liquid bloody stools. With older children who are able to talk, there may be a history of slight abdominal cramps. The presence of a considerable amount of blood in the terminal end of the ileum and colon apparently sets up a hyperperistalsis and/or a mass peristalsis of the colon accounting for the cramps. Because of this hyperperistalsis and/or mass peristalsis the action of digestive juices on the blood is at a minimum and the blood is frequently passed relatively unchanged. Proctoscopic and sigmoidoscopic examination may be used in occasional cases to rule out polypi low in the sigmoid or rectosigmoid.

There are two definite findings which aid in differentiating bleeding from a Meckel diverticulum and an intussusception:

1. In intussusception there is usually an admixture of blood and mucus, while in a bleeding diverticulum there is usually little or no mucus.

2. In intussusception there is obvious evidence of intestinal cramping, manifested in younger children by frequent grasping of the abdomen and by flexion of the thighs on the abdomen during the attack of colic.

There will not be this severe cramping pain in the presence of a bleeding diverticulum. The red blood cell count and the hemoglobin content after an initial massive hemorrhage may not show any significant change if determined during the first two to three hours after the hemorrhage. This is, of course, due to initial hemoconcentration. After several hours more there will be a definite drop in the red blood cell count and in the hemoglobin content. It is felt that the volume of blood passed per rectum is only an indication that bleeding of an active type is present and does not in any way represent the actual amount of blood lost. In a number of cases of acute hemorrhage there has been the history of the passage of 500 to 600 cc. of measured blood. At the time of operation, one to two hours later, it was found that the terminal end of the ileum and the entire colon were rather markedly distended with blood, so that the actual loss of blood might easily have been more

nearly 1,500 to 2,000 cc. This in itself is a tremendous amount for a child 18 months to 4 years old over a three to four hour period.

CASE 3.—C. L. N., a male infant aged 18 months, was admitted to the hospital with the history that for six days he had passed two to three bloody stools each day. According to the parents, the stools were of dark brown blood on most occasions, but twenty-four hours prior to his admission to the hospital he had had a massive hemorrhage of bright red blood amounting to "several cupfuls." There were no other presenting complaints. The infant had continued with his regular formula and apparently had had little or no abdominal distress. There had been no history of bloody or tarry stools prior to the onset of the present illness.

Examination on admission to the hospital revealed an extremely dehydrated white male infant of 18 months who was acutely ill. There was extreme pallor of the skin, mucous membranes and conjunctivas. The head and neck were normal, as were the lungs. There was moderate tachycardia, with a pulse rate of 130. Examination of the abdomen showed distention, with tympany throughout. There were no demonstrable areas of tenderness. Rectal examination revealed moderate dilatation of the rectal pouch. The material on the glove of the examining finger was apparently dark brown blood. Immediately after rectal examination, the patient passed approximately 300 cc. of brown liquid stool.

The red blood cell count was 1,500,000, with a hemoglobin content of 3.2 Gm. per hundred cubic centimeters. The white blood cell count was 17,100, with a normal differential count.

The patient's blood was typed and cross matched and a transfusion started, and exploration was begun approximately two hours after his admission to the hospital. After the induction of ether anesthesia the abdomen was opened by an incision through the lower part of the right rectus muscle. On entrance to the peritoneal cavity a loop of the terminal end of the ileum presented itself, which was moderately distended and appeared dark gray on inspection. The entire colon was distended with blood. Twenty-five centimeters proximal to the ileocecal valve a Meckel diverticulum was encountered, measuring 2.5 by 1.5 cm. in size. The diverticulum was excised, a standard technic being used. The abdomen was then closed in layers with continuous sutures of chromic surgical gut to the peritoneum and the posterior rectus sheath and interrupted sutures of silk 000 to the anterior rectus sheath. The wound was closed with sutures of silk. When the diverticulum was opened an ulceration measuring approximately 4 mm. in diameter was found at the junction of the gastric and the ileal mucosa. The patient made an uneventful recovery.

INTUSSUSCEPTION

An occasional Meckel diverticulum may become inverted and become the leading point of an intussusception, or the base of the diverticulum may be grasped by a peristaltic wave and become the leading point of an intussusception without inversion of the diverticulum.

A history of intussusception secondary to inversion or inclusion of the base of a Meckel diverticulum in an infant will, as a rule, be fairly typical. There may or may not be a history of previous diarrhea or moderately loose stools over a period of days. At the onset of the intussusception there may or may not be apparent acute abdominal

pain and obstipation, followed by the passage of bloody mucus and by distention. Nausea and vomiting will naturally follow if the intussusception goes unrecognized for any appreciable period. In most cases in which an inverted diverticulum has become the leading point of an intussusception the symptoms of complete obstruction will be more pronounced. As the head of the column of intussuscepting ileum becomes more telescoped, complete obstruction occurs much more rapidly. In a true cecocolic intussusception, actual complete obstruction may come relatively late, also, in cases in which an inverted diverticulum becomes the leading point of intussusception the amount of blood mixed with the mucus is usually greater.

CASE 4.—A female infant aged 4 months was admitted to the Children's Free Hospital with the history that five days previously she began to have obstinate constipation, with a gradual decrease in the amount of stool passed. Forty-eight hours prior to her admission the patient had slight nausea and regurgitated parts of several feedings. Twelve hours prior to her admission abdominal distention appeared, and it progressed rapidly. During these twelve hours, the infant had passed several small stools comprised entirely of a small amount of mucus mixed with dark blood.

Examination revealed an acutely ill female infant of 4 months. The head and neck were not remarkable. The heart and lungs were clinically normal. Examination of the abdomen revealed a rather notable degree of distention, with patterns of small bowel apparent under the skin. Percussion revealed tympany throughout. No definite mass could be made out, and there were no apparent areas of tenderness. Rectal examination revealed no masses in the rectum or rectosigmoid, and dark blood and mucus were found on the examining finger. Roentgenograms of the abdomen with the patient in an upright position showed loops of dilated small bowel with multiple fluid levels. No gas could be visualized in the colon.

A preoperative diagnosis of intussusception was made. With the patient under ether anesthesia, the abdomen was opened through an incision splitting the right rectus muscle. When the peritoneum was opened, multiple loops of distended ileum were encountered. Careful examination of the terminal end of the ileum revealed an intussusception approximately 10 cm. proximal to the ileocecal valve. The intussuscepted mass measured approximately 8 cm. in length. An effort was made to reduce the intussusception, but after approximately one half of the intussuscepted ileum had been reduced, it was impossible to reduce the remaining portion because of extreme edema and because of the extreme friability of the wall.

Resection of the intussuscepted mass was then carried out, and an end to end anastomosis was done. The abdomen was then closed with interrupted silk sutures.

Complete obstruction had been present in this patient for about thirty-six hours. This, together with the resection, was too much for her. She died about twelve hours postoperatively.

CASE 5.—A boy aged 2 years was admitted to the hospital with a history of frequent passage of bloody mucus for two days. Twenty-four hours prior to his admission there was beginning distention, which progressed rapidly, followed in ten to twelve hours by nausea and vomiting. There was no history of previous similar attacks.

Examination revealed an acutely ill child of 2 years with a temperature of 101 F., a pulse rate of 120 and a respiratory rate of 30. The head, neck, heart and lungs were normal. The abdomen was considerably distended, with definite tenderness and a tumor mass in the right lower quadrant. Rectal examination revealed nothing other than bloody mucus on the examining finger. The white blood cell count was 19,000, with 60 per cent polymorphonuclear cells. A roentgenogram with the patient in an upright position showed multiple loops of distended small bowel, with no gas in the colon. A preoperative diagnosis of intussusception was made.

The patient was explored after the induction of general anesthesia, and the intussusception mass was found involving the terminal end of the ileum and ascending colon. Approximately two thirds of the intussuscepted ileum was reduced without difficulty. The final 8 cm. could not be reduced because of extreme edema. This portion was then resected and a side to side anastomosis carried out. The abdomen was closed in layers with interrupted silk sutures, and the patient made an uneventful recovery. Opening of the intussuscepted mass revealed a Meckel diverticulum, the base of which had become the leading point of the intussuscepting mass.

INTESTINAL OBSTRUCTION

A Meckel diverticulum and/or other remnants of the omphalomesenteric vessels may be the cause of intestinal obstruction. The diverticulum may remain attached to the umbilicus, and loops of bowel may rotate about this and cause obstruction. On the other hand, the remnants of the omphalomesenteric vessels may become detached and adhere to any peritoneal surface. This adherance to any peritoneal surface may provide a hiatus through which loops of bowel may herniate or a point around which loops may rotate.

Case 6.—F. S., a boy aged 10, was admitted to the hospital with the chief complaints of pain in the abdomen, which was more severe about the umbilicus, nausea, vomiting and distention. The onset of the pain had been about ten hours prior to his admission, with colicky pains centered about the umbilicus. After this he became nauseated and began vomiting. Vomiting and distention became more severe until the day of admission. There had been several episodes of watery stools that morning. The past history indicated no previous similar attacks.

Physical examination revealed a markedly dehydrated, acutely ill patient in obvious distress. The head, neck, heart and lungs were clinically normal. Examination of the abdomen revealed an appreciable degree of distention, with generalized tenderness. Tenderness was more acute throughout the right lower quadrant. No masses could be made out. Rectal examination disclosed no masses and only a moderate amount of tenderness. The white blood cell count was 18,350, with 90 per cent polymorphonuclear cells.

A preoperative diagnosis of probable ruptured appendix was made, and the abdomen was explored through a transverse incision on the right side placed just above the level of the anterior superior iliac spine. The appendix was visualized and found to be normal. Further exploration of the abdomen revealed multiple loops of moderately distended ileum, with several loops of collapsed ileum in the right lower quadrant. A Meckel diverticulum measuring 6 by 2 cm. was found attached to the parietal peritoneal area of the umbilicus, around which a loop of ileum had been caught and had become obstructed at this point. The mass was

broken up by blunt dissection, and it was found that a loop of ileum had become attached to an inflamed area in the wall of the diverticulum and had rotated about the umbilical attachment one and a half times in a clockwise direction. The tip of the diverticulum was detached, the rotated portion of ileum freed, the obstruction thus being relieved, and the diverticulum resected. The abdomen was closed in layers, and the patient made an uneventful recovery.

CASE 7.—Mrs. T. M., aged 52 years, was admitted to the hospital with the chief complaint of abdominal pain localized in the lower part of the abdomen, nausea, vomiting and pronounced distention. The onset of the present attack had been about thirty-six hours prior to her admission to the hospital, with rather sudden, severe pain in the lower part of the abdomen, followed in several hours by nausea and vomiting. After this the pain became more severe and was described as "coming in waves." From that time until the time of her admission to the hospital the nausea and vomiting had progressed and the degree of abdominal distention had become more severe.

The past history revealed that "about thirty years" previously the patient had had some sort of operation in the upper abdominal area for splanchnoptosis. Ten years previously she had had a pelvic laparotomy, with hysterectomy and appendectomy. The remainder of the past history was not contributory. There had been no previous similar episodes.

Physical examination revealed an acutely ill white woman, who appeared to be in moderate shock although the systolic blood pressure was 110 mm. of mercury. The temperature was 97 F., the pulse 120 and the respirations 30. The skin of the patient had an ashy, dusky hue and was covered with profuse perspiration. The head and neck were clinically normal. The heart and lungs were normal except for a moderate tachycardia. Examination of the abdomen disclosed a severe degree of distention throughout. There was no tenderness in the upper area, and no masses could be made out. In both lower quadrants there was diffuse tenderness, of considerable degree in the suprapubic region. On pelvic examination there was a sensation of fulness in the cul-de-sac, with decided tenderness on manipulation of the cervix.

A roentgenogram of the abdomen with the patient in the upright position showed multiple loops of distended small bowel, with a few fluid levels. A blood count revealed 4,240,000 red blood cells, with 12 Gm. of hemoglobin per hundred cubic centimeters, and 11,300 white blood cells, with 89 per cent polymorphonuclear cells and 11 per cent lymphocytes.

It was felt at the time that there was a complete obstruction of the terminal end of the ileum, and because of the extreme tenderness in the cul-de-sac it was also suspected that there was gangrenous bowel there. A tentative diagnosis of intestinal obstruction secondary to adhesions from a previous operation was made.

Several hours later the abdomen was explored through an incision low in the right rectus muscle with the patient under spinal anesthesia induced by tetracaine hydrochloride and dextrose. In the abdomen multiple loops of distended small bowel were encountered. The cecum and the ascending colon were collapsed. Exploration of the cul-de-sac revealed a loop of gangrenous ileum measuring approximately 30 inches (76 cm.). The cause of the gangrene was found to be a tremendous Meckel diverticulum that measured 15 cm. in length. The tip of the diverticulum was attached to the sacral promontory by two fibrous strands that were about 2 cm. in length. These strands had formed a triangular hiatus through which the ileum had herniated and become gangrenous. The strands were divided and the gangrenous ileum released. The loop of involved ileum was then resected. The

distal segment was so close to the ileocecal valve that it was necessary to do an ileocecostomy. The Meckel diverticulum was resected after the manner described elsewhere and the abdomen closed in layers.

The patient had a stormy course for the first seven days and then improved and proceeded to complete recovery.

This case demonstrates how the omphalmomesentric vessels may attach to any peritoneal surface and cause obstruction.

COMMENT

The cases presented here adequately demonstrate surgical emergencies which may occur secondary to the presence of a Meckel diverticulum.

There is a technical point which might be emphasized, that is, the surgical excision of the diverticulum. The surgeon may occasionally encounter a Meckel diverticulum that is so small at the base that he may be tempted to remove the diverticulum by simple ligation and inversion of the base, patterned after ligation and inversion of the base of an appendix. Obviously, if this type of procedure is carried out with the base of a Meckel diverticulum that is of any size, narrowing of the lumen of the ileum at this point will necessarily follow. This will be particularly true in cases in which the patient is only several months old. The diameter of the ileum in infants is small, and any encroachment on the lumen may seriously diminish it, with probable obstruction. For teaching purposes, for both interns and students, the technic has been rigidly standardized for removal of a Meckel diverticulum. The base of the diverticulum is clamped across in a transverse direction with two thin Bainbridge muscle clamps and the diverticulum divided between the clamps with actual cautery or with the scalpel attachment of the Bovie. The primary suture line is made with chromic surgical gut 000 after the Parker-Kerr technic. This suture line is further reenforced by interrupted Lambert sutures of silk 000. If deemed necessary, it may even be further reenforced by a third tier of sutures without encroaching on the lumen of the ileum.

SUMMARY AND CONCLUSIONS

1. Various surgical complications may present themselves as the result of a Meckel diverticulum, as brought out in the case reports presented.

2. A standardized technic for removal of a Meckel diverticulum is described.

3. It is emphasized that in the diagnosis of any obscure abdominal complaint, with atypical findings, in extremely young or in older patients the presence of Meckel's diverticulum must be borne in mind. It is also emphasized that in cases in which the gross appearance of an appendix does not fit the clinical picture the terminal 35 inches (76 cm.) of ileum must be examined.

4. Severe, life-endangering hemorrhage can and does occur from Meckel's diverticulum in children. In adults a Meckel diverticulum that is bleeding may be occasionally confused with bleeding from a peptic ulcer.

5. Intestinal obstruction may be the result of a Meckel diverticulum. This may occur as a result of intussusception secondary to an inverted diverticulum or the inclusion of the base of a diverticulum. It may occur secondary to torsion of loops of small bowel around the attachment of the Meckel diverticulum to the peritoneal surface of the umbilicus or to any peritoneal surface.

DISCUSSION

DR. ROBERT M. WANSBROUGH, Toronto, Canada: Last year my associates and I reported here some 118 to 120 cases of Meckel's diverticulum with complications. Therefore the first two papers read are most interesting to me. I was impressed by the large number of patients requiring resection. Small children are the ones who do not stand resection. They probably survive the first operation but not the second, if it is done in two stages. In our group of cases we performed resection only when it was obvious that we were going to have difficulty after the reduction of the intussusception, and we did a side to side anastomosis. Among children below 1 year of age the mortality was high when end to end anastomosis was performed.

The next point was the massive hemorrhage. Our observations in cases of massive hemorrhage from an ulcer in Meckel's diverticulum in the Hospital for Sick Children have not changed. Hemorrhage is the commonest cause in small children.

POLYPOSIS OF THE COLON

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HEREDITARY polyposis of the colon is not a congenital disease but a mendelian dominant which is transmitted by father or mother and may be inherited by children of either sex.

The polypi are not present at birth but usually appear between puberty and the age of 30. The valuable work by Harrison Cripps,[1] Cuthbera Dukes [2] and later Lockhart-Mummery and Dukes [3] has definitely established the hereditary predisposition and has suggested that its cause is a genetic defect resulting in excessively rapid growth of the intestinal epithelium which is characterized at first by hyperplasia and later by the formation of adenomas and finally progresses, in a large proportion of cases, to carcinoma.

The symptoms of this disease are usually diarrhea, the passage of mucus and blood, pain in the lower abdominal area and tenesmus. The condition is usually diagnosed as colitis, and the true nature of the disease is only established after sigmoidoscopic examination. At this examination great numbers of polypi may be seen, varying in size from small sessile pink elevations to huge pedunculated tumors.

In many cases it is impossible to establish a history of the disease in the family, although if careful inquiry is made it may be discovered that either the father or the mother suffered from chronic diarrhea for long periods.

For many years this condition has been treated in a conservative way, the treatment being limited to removal of polyps from the rectum and the lower pelvic region of the colon either by cutting instruments or by diathermy. Recently, particularly since the work of Dukes definitely established that carcinoma subsequently develops in the majority of cases, more radical therapy has been attempted, the favorite operation being an abdominoperineal excision of the rectum and sigmoid with permanent colostomy opening. The operation has been per-

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1. Cripps, H.: Tr. Path. Soc. London **33**:165, 1882.
2. Dukes, C. E.: Cancer Rev. **5**:241, 1930.
3. Lockhart-Mummery, J. P., and Dukes, C. E.: Lancet **2**:586, 1939.

formed in the belief that the polypi which most commonly became malignant were in the lower region of the colon. Another reason for this form of therapy was the belief that a total colectomy renders the patient's life so miserable as to be almost intolerable.

However, within the past two years it has been my good fortune to have had extremely gratifying results in the treatment of 4 patients suffering from polyposis by the performance of a one stage total colectomy with ileorectal anastomosis. This paper is presented with the idea of discovering whether the assembled group here has had any similar experiences and what their success has been.

CASE 1.—J. L., a man 44 years of age, took ill suddenly in May 1945 in Holland with vomiting and abdominal cramps. He had had symptoms of subacute obstruction for the previous two months, and a diagnosis of acute obstruction was made. A laparotomy was performed, and a small carcinoma of the sigmoid was found. A transverse colostomy was done. He was transferred to another hospital, where a Mikulicz type of resection was done. He was admitted to the Montreal Military Hospital in August 1945 on return from overseas. The two colostomy openings were functioning, and two polyps protruded from the lower one. These were removed and reported nonmalignant. A sigmoidoscopic examination revealed two more polyps in the rectum, which were removed. A diagnosis of polyposis was made, and on Aug. 27, 1945, a total colectomy with an end to end ileorectal anastomosis was done, both areas of colostomy being resected. His postoperative course was uneventful. The pathologic report showed that the entire length of bowel was studded with polypi, all nonmalignant. He was admitted in December 1945, having only one or two bowel movements a day, and a sigmoidoscopic examination revealed no polyps. He was again admitted in April 1946. He had gained 35 pounds (16 Kg.), and no polyps were seen. He was reexamined in September 1946, when sigmoidoscopic examination and a roentgenogram after a barium enema showed nothing abnormal. He was having one bowel movement a day and had returned to work.

CASE 2.—W. F. was a man 47 years of age. In 1942 he had crampy pains in the lower part of the abdomen and passed blood in his stools. He was admitted to a hospital in Horsham, England, where several polyps were removed from the rectum. He was then sent home to Canada, with the diagnosis of multiple polyposis, and was admitted to St. Anne's Hospital on arrival, where more polyps were removed. He was readmitted to St. Anne's in 1943 for the removal of polyps and again in 1944, when seven were removed. He was hospitalized at the Royal Victoria Hospital in 1945, where polyps were removed, this time transabdominally, and again in February 1946, by which time he had lost 30 pounds (13.6 Kg.). In September 1946 he was admitted to Queen Mary Hospital, complaining of crampy abdominal pain and stools spotted with blood. His weight was now 100 pounds (45 Kg.), a loss of 50 pounds (22.7 Kg.) in all. Polyps were again seen on sigmoidoscopic and roentgenologic examination, and all those within reach of the sigmoidoscope were removed. On Oct. 4, 1946, a one stage total colectomy was done, with an ileorectal side to side anastomosis. His postoperative course was uneventful. The pathologic report revealed over eight hundred polyps scattered from the cecum to the rectum, and one polyp in the cecal region showed malignant changes. He was at first having five to six loose stools each day, but by December 13 these were reduced to one or two a day.

Sigmoidoscopic examination and roentgenograms after a barium enema did not reveal the presence of any new growths.

One other exactly similar operation has been performed on a man of 52, with an equally good result.

More recently still, Dr. J. C. Armour, of the Royal Victoria Hospital, has given me permission to publish data on a case of polyposis with two carcinomas in which he successfully performed a one stage total colectomy.

From my experience in these 3 cases, the side to side anastomosis of the ileum to the rectum is the easier method. In my first case I made the anastomosis on the right side of the rectum below the peritoneal floor, but I believe this to be unnecessary as the sigmoidoscope can easily reach that portion of the rectum which is covered with peritoneum, and I therefore recommend the type of procedure described.

One necessary part of postoperative therapy would seem to be the adequate supply of protein. One of the patients reported on is free from diarrhea as long as he takes extra protein, but if he neglects to do this, his bowel movements rise to four a day. This point is being investigated further.

These cases are presented to show the danger of the development of malignancy in polyps in areas of the colon usually considered as fairly safe. They also show that total colectomy with ileorectal anastomosis can be done relatively easily and that the postoperative course of the patients is compatible with normal life and leaves them free from the danger of death from carcinoma of the large bowel.

If the experience of other surgeons is similar to mine, it would suggest that the treatment of choice in an established case of polyposis of the colon is the removal of all polyps within reach of the sigmoidoscope and, if the patient is in good condition, the immediate performance of a one stage total colectomy with ileorectal anastomosis.

DISCUSSION

Dr. Foster L. McMillan, Chicago: Lest we get the impression that the treatment of polyposis of the colon is always easy and can be done with a one stage procedure, I should like to stress one point, i. e., the high incidence of ulceration, erosion and infection in these cases, which many times necessitates a multiple stage procedure rather than a primary resection and restoration of continuity.

I should also like to call attention to the difficulty in estimating the extent of the polypoid involvement. Estimation by roentgenologic study occasionally is not satisfactory. Even examination of the colon at the time of operation does not always reveal whether the disease is diffuse or segmental in its distribution.

Dr. Paul I. Hoxworth, Cincinnati: At the University of Cincinnati Hospital we have been interested in the management of polyposis of the colon for some time. I should like, first, to congratulate Dr. Gardner on the approach which he has made in the 2 cases reported. It represents an approach which is made

all too seldom. We all realize that in the treatment of polyposis the type of operation must be adapted to the patient rather than the patient to the operation. However, there are two groups of cases in which ileorectal anastomosis for preservation of the sphincter is not suitable. One group is that in which frank carcinomatous change has occurred in the rectal segment before the patient reaches the surgeon. In the second group are those cases in which widespread involvement of the rectum with diffuse adenomatosis makes one question the advisability of destroying the entire rectal mucosa by fulguration in order to make an ileorectal anastomosis.

Colectomy followed by ileosigmoid or ileorectal anastomosis has been done by others and reported. We have recently performed three total colectomies, with combined abdominoperineal resection, in one stage, with recovery. Ileostomy is not desirable and should not be done if the rectum and sphincter can be preserved safely. However, the development of the Koenig-Rutzen bag has made it possible for patients subjected to ileostomy to be comfortable and has minimized the inconvenience.

I should like to make a plea, as others have done, for use of the term "polyposis" rather than "multiple polyposis" in describing this condition. The term "polyposis" signifies multiple polyps.

OBSTRUCTION DUE TO VOLVULUS OF THE COLON

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FOUR patients having acute obstruction due to volvulus of the sigmoid and 1 patient having acute obstruction due to volvulus of the cecum have served to emphasize certain diagnostic and therapeutic points.

In volvulus of the sigmoid, in older patients, there is usually a history of repeated attacks of partial obstruction or of constipation, while in younger patients the acute obstruction often occurs without any previous history.[1] The obstruction may be of many hours' duration, but the patient is not so sick as one might expect with carcinoma. The hemoglobin value and the red blood cell count are usually not much below normal. The abdomen is apt to be markedly distended. There may be little vomiting. There is pain over the dilated loop and especially where the twist puts a pull on the root of the mesentery. This pain will be severe if there is much interference with circulation. The roentgenograms show a remarkable distention with gas. There is a loss of haustral markings. The dilated loop usually extends to the left side of the diaphragm if the sigmoid colon is involved. The wall of the bowel appears to be very thick as seen at the flexion creases; occasionally it is possible to see the markings of the twist when a barium enema is given. The following case histories will serve to illustrate these points:

REPORT OF CASES

OBSTRUCTION DUE TO VOLVULUS OF THE SIGMOID

CASE 1.—C. M., a man 65 years of age, entered the Presbyterian Hospital on Oct. 24, 1940. He had had an attack of constipation one year before. This lasted four days, during which time he could not pass gas or have a movement. He was distended and nauseated. That attack was relieved by several colonic flushings. He had taken cathartics regularly ever since. He had had three short attacks of diarrhea in the two weeks preceding hospital admission. Eight days before coming to the hospital he became markedly distended, and he passed a little gas once two days before admission. There had been no movement or gas otherwise in spite

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1. Griffin, W. C.; Barton, G. R., and Meyer, K. A.: Volvulus of the Sigmoid Colon: Report of Twenty-Five Cases, Surg., Gynec. & Obst. **81**:287-294 (Sept.), 1945.

of colonic flushings, cathartics and oil. He had vomited everything taken by mouth for three days. He had never seen any blood in the bowel movements.

His past history was irrelevant. He was a 25 mile (40 kilometer) bicycle racer in his youth, and with the exception of polyarthritis twenty-five years ago he has been in good health.

Physical Examination.—He was a man of average build, markedly dehydrated and having pronounced abdominal distention. The reflexes were normal. There were several carious teeth. The pharynx was slightly injected. No abnormalities were noted in the heart or the chest. The abdomen was distended and there was an occasional high-pitched metallic peristaltic sound. No fluid could be demonstrated.

Fig. 1.—The flat roentgenogram of the abdomen showing remarkable distention with gas, the great thickness of the wall of the bowel as seen at the flexion creases and the dilated loop of the bowel extending to the diaphragm on the left side.

His temperature was 99.4 F., his pulse rate was 72, the hemoglobin value was 75 per cent, the red blood cell count was 3,900,000, and the white blood cell count was 8,500. His urine was normal. Six hundred cubic centimeters of bile-stained fluid was aspirated from the stomach. Rectal examination showed a dilated rectum without any tumor or blood (flat roentgenogram, fig. 1). Three thousand cubic centimeters of dextrose and isotonic solution of sodium chloride was given intravenously in the first twenty-four hours. Because of the pronounced distention, a cecostomy was decided on.

Operation.—With the patient under procaine hydrochloride infiltration anesthesia, a McBurney incision was made. The sigmoid was 6 or 8 inches (15.2 to 20.3 cm.) in diameter and it completely filled the lower part of the abdomen. The cecum was found with difficulty. A part of the cecum was delivered through the abdominal wall, and the peritoneum, fascia and skin were closed around it. A large rubber tube was passed into the cecum and tied with a linen pursestring suture. A large amount of gas was obtained.

Postoperative Course.—On the third postoperative day he contracted bronchopneumonia. There was a diffuse greenish sputum which showed Neufeld type 6 and type 31 pneumococci on culture. He was given sulfapyridine, and the chest became normal after three days. The cecostomy opening was irrigated twice daily with water, but it was fourteen days before he passed anything by rectum. The

Fig. 2.—Fluoroscopy of the colon, showing the folding and twisting of the mucosa, suggestive of a volvulus.

abdominal distention remained about the same. The stools failed to show any blood. Proctoscopic examination for 25 cm. showed no abnormalities.

Second Operation (Nov. 25, 1940).—A long left lower paramedian incision was made. The sigmoid was 3 feet (91.4 cm.) in length, 7 inches (17.8 cm.) in diameter, and it was tightly distended with gas. This loop of sigmoid had made a turn of 120 degrees in a clockwise direction so that the mesentery pressed on the distal part of the sigmoid and caused an obstruction. This immense loop of sigmoid reached above the xiphoid and back of the transverse colon and the stomach. A large rubber tube with several holes cut in the side was inserted into the rectum by an orderly and the tube was then guided up into the sigmoid by the operator. This allowed ready decompression. A number of hard, rocklike lymph nodes were

present along the bifurcation of the aorta. Since it seemed likely that there would be a repetition of the obstruction if this bowel was left in place, an obstruction resection of the sigmoid was performed. Raw spots were reperitonealized; the antimesenteric borders of the proximal and distal ends of the sigmoid were approximated with interrupted catgut sutures. The peritoneum and fascia were closed with catgut. The skin was closed with silk. Payr's clamps were applied and the bowel was cut with cautery (fig. 3).

Postoperative Course.—He again began to cough and expectorate thick mucus. The sputum contained type 6 Neufeld pneumococci. He was found to have a massive collapse of the left lung; respirations were between 30 and 40 a minute; sodium sulfapyridine was given intravenously. He coughed up the bloody mucus but contracted bronchopneumonia, and it was ten days before the respiration rate returned to normal. There was no wound infection. The total hospital stay was fifty-seven days. He gained weight and strength and returned for closure of the colostomy opening on April 14, 1941.

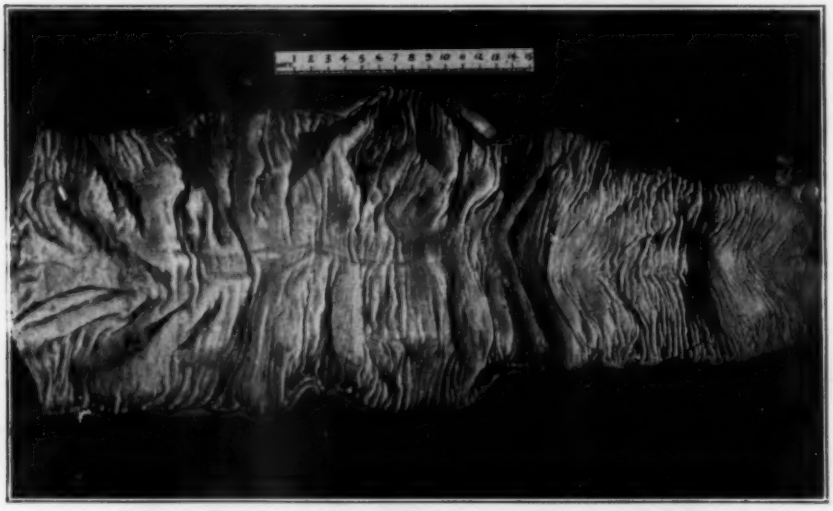

Fig. 3.—Photograph of the formaldehyde-fixed specimen of sigmoid resected in case 1. The hypertrophy of the musculature of the wall of the bowel can be seen. The ruler is 15 cm. in length.

Third Operation (April 14, 1941).—With the patient under procaine hydrochloride anesthesia the two-barreled colostomy opening was mobilized to the peritoneum; the mucosa was closed with catgut and a two layer interrupted linen suture was used on the muscularis. The fascia was closed with catgut and the skin with silk. A small rubber wick was placed down to the bowel.

Postoperative Course.—The next morning he again had a productive cough and some feeling of substernal oppression. He vomited twice. Respirations were 30 to 38. He was cyanotic. His temperature was 102.4 F. He had aspiration pneumonia in the upper lobe of the left lung. Cultures of the sputum showed Neufeld type VI pneumococci. He was given sulfathiazole, and the pulmonary infection cleared. His temperature returned to normal in four days.

He had normal movements by rectum, and the anastomosis held without drainage. He was hospitalized sixteen days. He returned to the hospital on June 27,

1941 for closure of the cecostomy opening. With the patient under procaine hydrochloride anesthesia, the wall of the bowel was freed by sharp dissection down to the peritoneum. The mucosa was closed with catgut. The muscularis and the serosa were closed with linen sutures. There was no fever and no drainage. He left the hospital in eleven days. It was noted in February 1942 that his bowels moved well and that he had gained weight and looked well, and in December 1946 that he was well and active and he had no further bowel trouble.

CASE 2.—A. M., a man 70 years of age, entered the Presbyterian Hospital on March 20, 1940. Nine months before he had had a prostatic resection at another hospital. Recovery was uneventful. After leaving the hospital he began to complain of constipation, sometimes having no movement for two or three days at a time. He took an enema daily and cathartics frequently. He never noticed any blood in his movements. He had his last movement three days before admission; numerous enemas were given without results. He did not vomit. During the past year, he had become easily fatigued. His eyesight was somewhat impaired. He had lost 10 pounds (4.5 Kg.) in weight; otherwise, his history was irrelevant.

Physical Examination.—He was a well nourished man and he did not appear acutely ill. He was slow in answering questions and he was obviously arteriosclerotic and senile. The physical examination revealed no abnormality otherwise except for the abdomen, which was somewhat distended and tympanitic, and peristaltic movements could be heard. No masses or tender areas were found. There were large scars of old bedsores on both buttocks. Rectal examination disclosed no abnormality. The hemoglobin value was 62 per cent; red blood cell count 3,750,000, and white blood cell count 5,800. His urine contained occasional hyaline casts. Chemical examination of several stools revealed no blood. Fluoroscopy of the colon on March 22 revealed pronounced distention of the colon with gas. There was an apparent obstruction of the rectosigmoid junction. No barium passed beyond this point. One roentgenogram (fig. 4) suggested volvulus. On March 23 the patient was placed in a knee-chest position and a proctoscope was passed 22 cm. without any abnormalities being seen. When this point was reached there was an explosive passage of gas and the abdominal distention was obviously decreased. For several days thereafter he was placed in a knee-chest position and he was advised to spread the buttocks, and each time he would pass a large amount of gas. After three days, his movements were normal. He had another fluoroscopy of the colon: "The sigmoid was markedly dilated. No sign of obstruction was found. The splenic flexure and the transverse colon were also dilated. This suggests more an atonic dilatation than an obstructive lesion" (Dr. F. H. Squire).

He was discharged from the hospital, taking liquid petrolatum and using diet to prevent constipation. He returned to the hospital on September 20 with a history that he had had no trouble until six days before, when he stopped having movements and began to have abdominal distention. Large flushings did not give him relief nor had the knee-chest position given him relief. He was not having severe cramps.

Results of general physical examination were about as before, but the abdomen was tense and markedly distended. Proctoscopic examination for 24 cm. showed no pathologic condition. A Miller-Abbott tube was passed. A small amount of fluid was aspirated by suction. Fluid balance was maintained by intravenous administration of dextrose solution and isotonic solution of sodium chloride. The roentgenogram of September 22 showed that in the presence of an obstruction of the large bowel the ileocecal valve was competent, and intubation of the jejunum would not decompress the colon. Five days of suction and small warm enemas failed to give relief. A colostomy was decided on because of his senility. On September 26, with

the patient under procaine hydrochloride anesthesia, a 3 inch (7.6 cm.) long, right upper paramedian incision was made over the transverse colon. The transverse colon was delivered; a glass tube was placed under it, and a two barrel colostomy was done. When this was opened, a large amount of gas was passed. The colon was 3 or 4 inches (7.6 or 10.2 cm.) in diameter before it was decompressed. When the colostomy opening was made, the mucosa was found to be a dark brown color (melanosis). This had not been found in the rectum. The color in that part exposed to light gradually faded after a few days.

Postoperative Course.—He began to have movements by the rectum after three days. He had an uneventful postoperative course. He gained back his weight and health and he was brighter mentally than he had been for several years. Fluoroscopy of the colon on March 4, 1941 showed a large atonic smooth sigmoid and descending colon and no sign of obstruction.

Fig. 4.—The pattern of the mucosal folds in this fluoroscopic roentgenogram strongly suggests volvulus of the sigmoid.

CASE 3.—Miss M. C., 54 years of age, was admitted to the Presbyterian Hospital Oct. 7, 1941. She was perfectly well until four weeks before admission, when she experienced a pain in the left side of the groin which persisted for two weeks. She then experienced a pain in the left hip which radiated down the anterior surface of the left thigh. This was associated with a feeling of weakness of the left leg. For two weeks she had been having some cramping pain in the lower left portion of the abdomen. She had had no movement or passage of gas for four days. She had not vomited. The history was otherwise irrelevant.

Physical Examination.—She was a small, thin woman lying quietly in bed, apparently not having severe pain. Blood pressure was 164 systolic and 70 diastolic; the pulse rate was 80; the temperature was 99.2 F., and the respiration rate was 20. The general physical examination disclosed no abnormality for one of her age except that the abdomen was rounded and distended with gas and an occasional peristaltic sound was heard. On rectal examination, some hemorrhoids and skin tags were present; no tumor was palpable (fig. 6). Because of increasing cramps, pain and distention and because of difficulty in localizing the point of obstruction, a cecostomy was attempted.

Operation.—On October 8, with the patient under procaine hydrochloride infiltration anesthesia, a McBurney incision was made and part of what was thought

Fig. 5.—Flat roentgenogram of the abdomen with the Miller-Abbott tube passed to its full length, showing that this will not decompress an obstruction due to volvulus. The great distention with gas and the thickened wall of the bowel in profile are seen.

to be the cecum was delivered. The bowel was anchored to the skin with four or five catagut sutures. A tube was placed in the bowel and anchored with a purse-string suture. A large amount of gas and a small amount of liquid were obtained.

Postoperative Course.—The maximum temperature was 100.8 F.; it was normal after four days. The colostomy worked well. Irrigation of the colon through the cecostomy opening was started after four days, and she passed stool by rectum thereafter. There was no blood in any stool. The proctoscopic examination revealed

no abnormality. Fluoroscopy of the colon made on October 18 revealed a "filling defect in the sigmoid, probably carcinoma."

Second Operation.—On October 22 a left paramedian incision was made from the symphysis to 2 inches (5.1 cm.) above the navel. Exploration failed to show a tumor. The sigmoid colon was large and long and had immense blood vessels in its mesentery. This loop of sigmoid had made a double loop, and it was found that the most prominent part had been used to make the colostomy. The appendix and the cecum were adherent to the edge of the sigmoidostomy as were two appendices epiploicae from the lower part of the sigmoid loop. These appendices epiploicae were acutely inflamed. The appendix was removed while the adherent loops of the bowel were being freed. The stump was inverted with a linen purse-

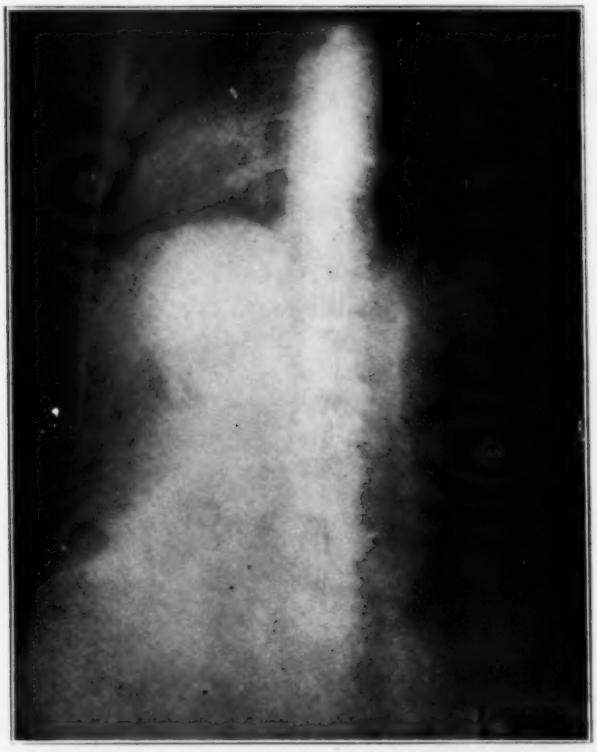

Fig. 6.—Flat roentgenogram of the abdomen, showing the distention of the sigmoid with gas, the thickening of the wall at the flexion creases and the loop of bowel extending to the left diaphragm.

string suture. Because of the presence of the colostomy in the sigmoid loop, a lateral anastomosis was decided on. This was made between the first part of the sigmoid just distal to the descending colon and the sigmoid just above the rectum. A three layer anastomosis 2 inches in length was made, linen being used for the outer two layers and catgut for the mucosal stitch. The fascia was closed with catgut and the skin was closed with silk.

Postoperative Course.—A Levine tube was left open in the stomach for forty-eight hours. Isotonic solution of sodium chloride and dextrose was given for two days. The third day the patient took fluids without trouble. Her temperature did

not go above 100 F. She left the hospital fifteen days after the operation. She resumed teaching school four weeks after leaving the hospital. The sigmoidostomy opening closed spontaneously. She takes a drachm (4 cc.) of liquid petrolatum each night. She has normal movements. She has gained weight and strength. Fluoroscopy of the colon ten weeks after operation showed a normal functioning lateral anastomosis. There was no sign of tumor.

CASE 4.—A 28 year old Negro soldier entered the 119th Station Hospital at Finschaffen, New Guinea, Feb. 16, 1945 with a history of abdominal cramps for six days. He had had no bowel movement for six days. He had had severe cramps for twenty-four hours and had not passed any gas in that time. He had noticed abdominal distention for twenty-four hours and he had vomited several times during that time.

Fig. 7.—Flat roentgenogram of the abdomen showing a markedly dilated sigmoid filled with gas and extending under the left diaphragm. In this case, acute in type, the wall of the bowel is not so thick as seen in those of the more chronic type.

He had an obvious obstruction of the large bowel, roentgenograms showing the colon to be from 5 to 6 inches (12.7 to 15.2 cm.) in diameter, and it extended up under the left diaphragm (fig. 7). The walls of the colon were obviously hypertrophied as seen roentgenologically. His maximum pain was just below and to the left of the navel. A preoperative diagnosis of volvulus of the sigmoid was made.

Operation.—A long left paramedian incision was made which showed the hypertrophied sigmoid colon to be 5 inches in diameter. There was a 360 degree twist in a clockwise direction. The sigmoid vessels were large and numerous. The redundant loop was untwisted and a large rectal tube which had been inserted

before the operation was passed on up into the sigmoid. The distended bowel was deflated through this tube. Since the loop was a potential source of repeated obstructions, an obstruction resection of the sigmoid colon was done. The specimen was 54 cm. long after fixation. His maximum postoperative temperature was 100.4 F. and it was normal after three days. A spur crusher was applied on the second postoperative day, and it had cut through by the seventh day.

Penicillin, 50,000 units, four times a day, was given for seven days. On the seventh postoperative day, the patient experienced a severe colic-like pain in the right flank. He passed red blood in his urine. He was evidently suffering from a ureteral calculus. After two days, the urinary upset subsided.

Fig. 8.—Flat roentgenogram of the abdomen, showing the dilated loop of cecum filled with barium and numerous small bowel patterns above it, filling the remainder of the abdomen. The remainder of the colon cannot be seen in the flat roentgenogram.

Thirty days after the resection, the two barrel colostomy opening was closed, procaine hydrochloride infiltration anesthesia being used. The mucosa was closed with catgut and the muscularis was closed with silk.

OBSTRUCTION DUE TO VOLVULUS OF THE CECUM

Case 5.—Miss N. D., aged 64, entered the Presbyterian Hospital on Oct. 18, 1942 with a history of a duodenal ulcer which was treated three years before. She had had distress in the lower part of the abdomen, more or less cramping in

nature, for two years. Several fluoroscopies of the colon have failed to show any pathologic condition. One year before she had had attacks of generalized abdominal pain which lasted from one to three hours. She was nauseated and vomited a large amount with one attack. She took 1 ounce (30 cc.) of liquid petrolatum daily for months but stopped after the severe attack. Gallbladder dye given previously showed a normal gallbladder. For the past four or five months she had not felt well. For three weeks she had had increasing constipation with periods of diarrhea. At times there have been severe cramps with some swelling of the abdomen. She has been on a soft diet for one month; no blood was seen in the stool. Three days before admission she had a fluoroscopy of the stomach which showed slight spasm in the duodenal cap. She was given 2 ounces (59 cc.) of liquid petrolatum at the end of the fluoroscopy and an enema. She became nauseated and vomited after the enema. She had abdominal cramps from that time on with increasing swelling of the abdomen. She did not pass any barium after taking the enema.

Physical Examination.—The patient was a moderately well developed 64 year old woman who was somewhat dehydrated. She was tired and sick. Results of the general physical examination were not important except that the abdomen was markedly distended. There was a palpable enlarged loop of bowel in the left lower quadrant which was tender to touch. Bowel sounds were hyperactive. Pelvic examination failed to show any pathologic condition. Flat roentgenograms of the abdomen showed: "Multiple dilated loops of small bowel. There is a large amount of barium in the colon" (fig. 8). Her hemoglobin was 13 Gm.; her red blood cell count 4,500,000, and her white blood cell count 10,800; her urine was normal.

Operation.—With the patient under ethylene anesthesia, a long left paramedian incision was made. The cecum was 5 inches in diameter and was tightly distended with gas. There was a tear in the taenia 1½ inches (3.8 cm.) long on one side of the cecum and 2 inches on the other. It was not through the muscularis. There was a 180 degree rotation of the long distended cecum which had a long mesentery. The twist was released. A silk pursestring suture was placed in the cecum and a needle was inserted and the bowel was decompressed. The pursestring was tied, closing the needle point perforation in the cecum. The two longitudinal taeniae were repaired with catgut. The cecum was then fixed to the lateral abdominal wall and to the pelvis with catgut so that further twisting was prevented.

Postoperative Course.—The postoperative course was uneventful. Her maximum temperature was 100 F. and she was afebrile after eleven days. She passed gas after eighteen hours. She began to pass the barium on the third postoperative day. She is well and has had no bowel complaints in the four years following operation.

SUMMARY

OBSTRUCTION DUE TO VOLVULUS OF THE SIGMOID COLON

In obstruction due to volvulus of the sigmoid, in older patients, there is usually a history of repeated attacks of partial obstruction or of constipation; while in younger patients the acute obstruction often occurs without any previous history.[1] The obstruction may be of many hours' duration, but the patient does not appear as sick as one might expect with carcinoma. The abdomen is apt to be markedly distended and vomiting occurs late. The hemoglobin value and the red blood cell

count are usually not much below normal. There is pain over the dilated loop, and it is especially pronounced where the twist puts a pull or pressure on the root of the mesentery. This pain will be severe if there is much interference with circulation. The roentgen examination shows: 1. There is remarkable distention with gas. 2. The haustral markings are lost. 3. The dilated loop extends to the left side of the diaphragm. 4. The wall of the bowel appears to be very thick as seen at the flexion creases. 5. Occasionally, it is possible to see the markings of the twist when a barium enema is given.

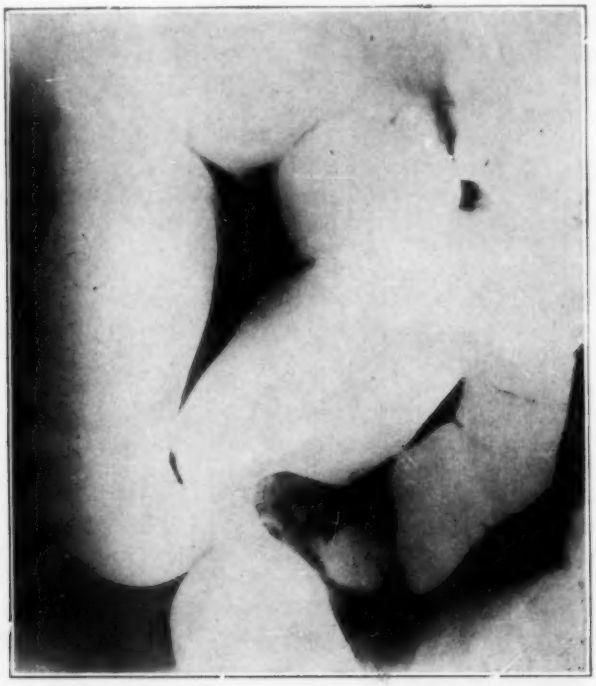

Fig. 9.—Roentgenogram taken of the bowel filled with barium, showing the tremendous size of the sigmoid and how difficult it would be to anchor such a bowel in any position.

Treatment.—Decompression may be obtained by placing the patient in the knee-chest position or by doing a proctoscopic examination. In very sick patients, cecostomy with the patient under procaine hydrochloride anesthesia is indicated; such patients should have resection of the sigmoid later. Obstruction due to volvulus is not relieved by intestinal intubation and suction. After establishment of fluid balance, obstruction resection is the treatment of choice. This can be easily accomplished as the dilated bowel falls out of the abdomen. Payr clamps can be applied and the excess bowel can be removed immediately. Lat-

eral anastomosis will give good results in some. Untwisting and fixation leave a long loop, and further trouble has been the general rule as seen in the case of a 34 year old woman, E. H., who was under the care of another surgeon. She had repeated attacks of obstruction of the large bowel which had been relieved by passing a large tube through the twist when she was in the knee-chest position. During one acute attack, all attempts at decompression failed and an exploratory laparotomy was performed. The large loop of the sigmoid was untwisted and then attached to the abdominal wall at several points to prevent further twisting. She continued to have attacks of obstruction and constipation, and the accompanying figure 9 shows the size of the sigmoid and suggests that such patients are better treated by resection than by fixation. When an interval operation can be performed, resection and end to end anastomosis are feasible.

OBSTRUCTION DUE TO VOLVULUS OF THE CECUM

Volvulus of the cecum depends on the failure of fixation of the colon.[2] In acute obstruction due to volvulus of the cecum, there is an associated obstruction of the small bowel early. Vomiting occurs much earlier and the patient will suffer from dehydration and will appear more sick than the patient with a similar lesion in the sigmoid. A Miller-Abbott tube with suction will not relieve such a lesion. On roentgen examination, the wall of the cecum is not so thick as seen in volvulus of the sigmoid, nor does it extend as high as the left side of the diaphragm. Early operation is indicated. Untwisting with fixation to the bottom of the pelvis and left pelvic wall is the safest procedure. If the bowel is gangrenous, resection with anastomosis between ileum and transverse colon is indicated. If the untwisting and fixation fail to give permanent relief, resection of the redundant bowel with lateral anastomosis is indicated at a second operation.

58 East Madison Street.

2. Rothman, M.; Bruckner, J. P., and Zetena, D. F.: Volvulus of the Cecum and Ascending Colon with a Review of the Literature and Presentation of a Case, Am. J. Surg. **60**: 292-297 (May) 1943.

CARCINOMA OF THE RECTUM AND RECTOSIGMOID

A Statistical Analysis of Eight Hundred and Forty-Four Cases

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THIS statistical study covers all patients with carcinoma of the rectum and rectosigmoid admitted to the Veterans Administration Hospital, Hines, Ill., from 1931 to 1946. This institution has been the tumor center for all Veterans Administration hospitals in the Middle West and the southern states, and there has been accumulated a wealth of material for study and analysis. The total number of patients admitted to the institution for the fifteen year period has been 131,279. Of this number, 16,097 have been admitted for malignant tumors. There have been 1,341 cases of carcinoma of the colon and rectum; in 844 of these there was carcinoma of the rectum and rectosigmoid, and in 497 there was carcinoma of the remainder of the colon.

SYMPTOMS

Character of Symptoms.—The frequency of the most important symptoms in 400 male patients suffering with carcinoma of the rectum and rectosigmoid is given in table 1. These are the symptoms recorded in the charts by a large number of examining physicians. Unquestionably, all the symptoms, with the exception of those of acute obstruction, occurred with greater frequency than was recorded. If every stool were examined carefully by the patient or the physician, practically all patients with carcinoma of the rectum would at some time show

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Read at the fourth annual meeting of the Central Surgical Association, Chicago, Feb. 22, 1947.

These data have been carefully correlated by the Department of Tumor Research under the direction of Dr. Robert Schreck.

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gross evidence of bleeding; a similar, more careful inquiry would undoubtedly show a higher incidence of constipation, diarrhea and rectal discomfort. A symptom must have a certain degree of severity before the patient mentions it or before the examining physician records it. This table presents fairly accurately the frequency of the symptoms which have attained sufficient importance to be of diagnostic significance.

Bleeding from the rectum was present in 76.5 per cent of patients; in 36 per cent it was the first symptom noted. The bleeding may appear as blood-streaked stools or occasionally as a severe hemorrhage. More commonly the stool is described as foul-smelling and containing a mixture of blood, mucus and perhaps pus. As is well known, carcinoma high up in the rectum obstructs venous drainage, producing what appears on a cursory examination to be ordinary internal and external hemorrhoids. Indeed, the first symptom may be a severe attack of prolapsed thrombosed hemorrhoids. Twelve per cent of the 400 patients had been treated for hemorrhoids, most of them having undergone hemorrhoidectomy. It is inevitable that any surgeon who performs operations for hemorrhoids without previous proctoscopy will sooner or later perform a hemorrhoidectomy on a person with carcinoma of the rectosigmoid. It is probable that in an ordinary general practice not more than 1 or 2 patients have carcinoma of the rectum of 100 patients who have rectal bleeding. With few exceptions, the condition will be recognized in these if a digital examination alone is performed. If the bleeding is of recent origin in a patient past middle age, few physicians fail to examine the rectum digitally. Unfortunately, a patient may have bleeding which is due to hemorrhoids intermittently for many years, and the physician fails to recognize that in this particular instance the bleeding is due to cancer rather than to simple hemorrhoids. Five per cent of the patients gave a history of having had bleeding hemorrhoids for the preceding ten years or more. The fact that carcinoma of the rectum not infrequently develops in a person who is known to have had hemorrhoids over a period of years necessitates a digital examination no matter how many examinations have been made during the previous months or years.

TABLE 1.—*Frequency of Important Symptoms in Four Hundred Patients*

Bleeding	76.5%
Loss of over 10 pounds in weight	67.2%
Diarrhea	40.5%
Pain in the rectum	24.7%
Constipation	23.2%
Abdominal pain	12.0%
Small stools	5.2%
Alternating constipation and diarrhea	5.1%
Acute obstruction	5.0%

Loss of weight is the second most frequent symptom. A loss of over 10 pounds (4.5 Kg.) occurred in 67.2 per cent of the cases; there was a loss of over 15 pounds (6.8 Kg.) in 53.2 per cent. In only 20 per cent of the histories was there no mention of loss of weight. Although few patients mention loss of weight as a presenting complaint, it occurs not only frequently but also, contrary to general opinion, rather early in the course of disease. Even a loss of a few pounds of weight in a patient who has rectal bleeding is an exceedingly significant symptom.

Frequent bowel movements occurred in 40.5 per cent of cases, this being the principal symptom in 23 per cent. Usually the patients described the diarrhea as frequent watery stools containing blood and mucus; in others the diarrhea consisted of a frequent urge to defecate, which would bring forth little if any true evacuation. Diarrhea is a more common presenting or associated complaint in carcinoma of the rectum than constipation, which in this series was recorded in only 23.2 per cent. A history of alternating diarrhea and constipation, a supposed frequent accompaniment of the disease, was obtained in only 5.1 per cent of patients. A history of pencil or ribbon-like stools was obtained in 5.2 per cent, and 5.0 per cent were admitted with almost complete obstruction. A change in bowel habits, in the form of either diarrhea or constipation or both, was present in 73.8 per cent, the diarrhea being more frequent than the constipation. Pain in the region of the rectum or pain on evacuation occurred in 24.7 per cent. Most patients with carcinoma of the rectum low enough to be felt by the examining finger will, on careful inquiry, give a history of some rectal discomfort or of some tenesmus, probably a much higher percentage than our figures indicate. Abdominal pain which could usually be attributed to partial obstruction was found in 12 per cent. In 2 patients appendectomy was performed for this type of pain. Vague abdominal distress is much more common but is overshadowed by the severity of the other symptoms.

A number of miscellaneous complaints appeared as the first symptom, such as rectal discharge, fistula-in-ano, rectal abscess, protrusion, dysuria, rectovesical fistula, weakness, backache, sciatica and the symptoms of metastasis to the liver, lung, groin, brain and jaw.

Duration of Symptoms.—From 1931 to 1940 the average duration of symptoms from the alleged time of the onset of illness until the patient presented himself to a physician was 11.3 months. With the passage of the years the interval gradually lessened, and in the period from 1940 to 1946 it had dropped to 9.7 months. The median in both groups, however, was approximately seven months; that is, half the patients presented themselves before the symptoms had persisted for seven months and the remaining half after that time. It is often difficult to determine the date of the onset of symptoms. If a patient had

rectal symptoms, usually bleeding, over many years and the estimated time of the onset of malignant change could not be made, the record was not used in this calculation. Our figures are practically the same as those reported by Hayden and Shedden,[1] Malbin and Stenstrom [2] and McCormick.[3]

Offhand, one would expect that the symptoms would be of much longer duration in instances of inoperable cancer. As is true for many other types of malignant processes, such is not the case. During the period from 1940 to 1946, when the resectability rate was 45.6 per cent, the average duration of symptoms in patients in whom resection was performed was 9.2 months (206 cases), and in those subjected to no operation or to a palliative colostomy it was 10.4 months (210 cases). Any symptom must reach a certain degree of severity before the patient

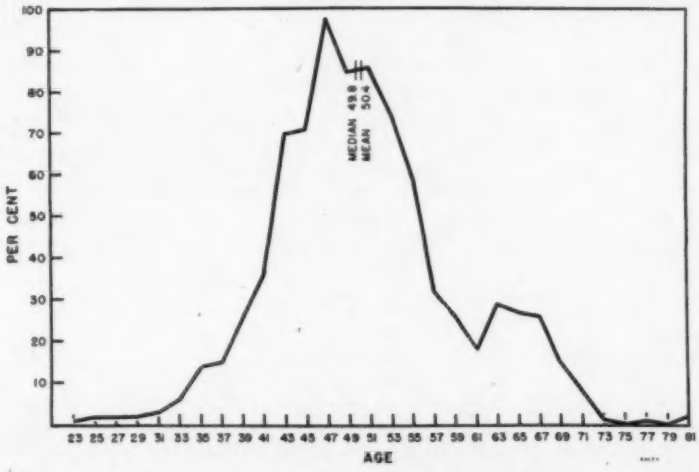

Fig. 1.—Age distribution of 844 patients with carcinoma of the rectum and rectosigmoid.

consults a physician. The time at which a group of persons consult a physician is about the same in all instances. If the patient has a rapidly growing tumor, he arrives at an early date, and if he has a slowly growing tumor, he arrives later. The tumors in the 2 instances may then possess an identical degree of resectability in spite of the difference in the duration of symptoms. The tumors were resectable

1. Hayden, E. P., and Shedden, W. M.: Carcinoma of Rectum: Study of Three Hundred and Three Cases, Surg., Gynec. & Obst. **51**:783-798 (Dec.) 1930.

2. Malbin, M., and Stenstrom, K. W.: Results of Treatment of One Hundred and Seventy-Three Cases of Carcinoma of the Rectum, Radiology **42**:545-549 (June) 1944.

3. McCormick, N. A.: Carcinoma of the Rectum, Radiology **42**:531-538 (June) 1944.

in 37 per cent of the patients admitted to the hospital for the primary treatment who had symptoms for six months or less, in 40 per cent of those who had symptoms for over six months to a year, in 36 per cent of those who had symptoms for over a year but under two years and in 37 per cent of those with symptoms for over two years. There is much less correlation between duration of symptoms and resectability than one would expect. The duration of symptoms was practically identical for the various age groups. If this factor is any criterion of the degree of malignancy present in cancer of the rectum, it would seem that the degree does not vary much, at least with respect to patients between the ages of 30 and 75. As Nathanson and Welch [4] have pointed out, some difference may exist, but it is not great.

Age Distribution.—Chart 1 shows graphically the distribution of patients according to age. It must be remembered that the study

TABLE 2.—*Data on Veterans of World War I for the Years 1940 to 1946*

Age Group	Percentage of All Veterans Living	Number of Patients with Carcinoma of the Rectum Admitted to Hines Hospital	Percentage of Patients with Carcinoma of the Rectum Admitted to Hines Hospital
34 to 39	0.03	1	0.2
40 to 44	11.7	25	5.0
45 to 49	46.6	124	31
50 to 54	31.3	147	37
55 to 59	8.6	60	15
60 to 64	1.2	22	5.5
65 to 69	0.4	18	4.5
Over 70	0.16	7	1.7

deals largely with a particular age group, that is, with veterans of World War I. The fact that the majority of patients seen with carcinoma of the rectum are in the fifth and sixth decades of life should not mislead one into believing that the disease has its highest incidence in these age groups. Dorn [5] has calculated the incidence of cancer of the rectum in each age group as related to the number of people living in the respective groups and has found that the incidence steadily increases with advancing years. Data on the age groups of veterans of World War I were available for the years 1940 to 1946. The percentage was determined for each age group in each year and then averaged for the entire six year period. In table 2 these percentages are compared with the percentage of patients in each age group of

4. Nathanson, I. T., and Welch, C. E.: Life Expectancy and Incidence of Malignant Disease: Carcinoma of the Gastrointestinal Tract, Am. J. Cancer **31**:457-466 (Nov.) 1937.

5. Dorn, H. F.: Illness from Cancer in United States, Pub. Health Rep. **59**: 33-48 (Jan. 14); 65-77 (Jan. 21); 97-114 (Jan. 28) 1944.

veterans who had carcinoma of the rectosigmoid. It is seen that there is a relatively higher incidence in the later years of life (chart 2).

PATHOLOGIC PROCESS

An original biopsy or a microscopic section made elsewhere was obtained in 771 cases. Periodically, some effort was made to grade the tumors as to the degree of malignancy, but the method as a whole was considered unsatisfactory and was discontinued. Under the classification of "adenocarcinoma," covering a total of 743 cases, are included tumors diagnosed as colloid adenocarcinoma and as papillary adenocarcinoma (table 3). Among the tumors with a lesser degree of malignancy there were ten malignant polyps, and among those with a greater degree of malignancy, there were thirteen undifferentiated carcinomas. There were also 10 instances in which the adenocarcinoma

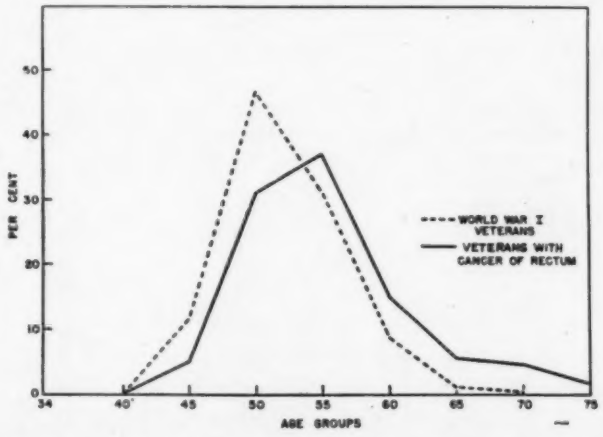

Fig. 2.—Age distribution of all World War I veterans from 1940 to 1946 and of veterans with cancer of the rectum.

was associated with polyposis. There were many more adenocarcinomas which we could only surmise had their origin in a preexisting polyp. One carcinoid, two lymphosarcomas and one fibrosarcoma have been added in order to include all malignant growths of the rectum and rectosigmoid for the period of observation. It is noted that the incidence of epidermoid or squamous cell cancer is low—0.7 per cent: Bacon [6] reported an incidence of 6.0 per cent, Hayden and Shedden [1] an incidence of 9.0 per cent, Cattel [7] an incidence of 1.7 per cent, Daniel [8]

6. Bacon, H. E.: Anus, Rectum, Sigmoid Colon: Diagnosis and Treatment, Philadelphia, J. B. Lippincott Company, 1938.

7. Cattell, R. B., and Williams, A. C.: Epidermoid Carcinoma of Anus and Rectum, Arch. Surg. **46**:336-349 (March) 1943.

8. Daniel, W. H.: Carcinoma of Rectum, California & West. Med. **63**:213-215 (Nov.) 1945.

an incidence of 5.0 per cent and Lawrence [9] an incidence of 1.5 per cent. The disease is much more common in women than in men. Raiford [10] reported 10 instances of epitheliomas of the rectum and anus in a total of 352 cases of cancer. Of the 10 patients involved, 8 were women and 2 were men. Keyes [11] observed 27 patients with epithelioma in a total of 470 with cancer; 23 of them were women. The largest series, 90 cases, was gathered by Kerr [12] from the Mayo Clinic. He stated that 5 per cent of all anorectal cancers are of the squamous cell type but that if one includes all carcinomas of the terminal 24 cm. of the bowel the incidence is only 1.5 per cent. Of his 92 patients, 57 were women and 35 were men, while only 35 per cent of all patients with carcinoma of the rectosigmoid were women and 65 per cent were men. According to his figures, the incidence, if the rectum and the rectosigmoid region are included, is approximately 1 per cent for male patients and 3 per cent for female patients.

TABLE 3.—*Classification of Tumors*

Adenocarcinoma	743
Anaplastic or undifferentiated carcinoma	13
Malignant polyp	10
Epidermoid cancer	5
Lymphosarcoma	2
Fibrosarcoma	1
Carcinoid	1

OPERABILITY AND MORTALITY

The total of 844 patients with carcinoma of the rectum and rectosigmoid in this study have been divided into two groups, one group admitted from January 1931 to January 1940 and the other from January 1940 to January 1946. This division was made because of the doubling of the resectability rate, which began in 1940 and was accompanied with a sharp reduction in mortality for all procedures. Several factors were responsible for this improvement in addition to the increased clinical and surgical experience. Most important were the better understanding of the importance of preoperative preparation, with special reference to the maintenance of the fluid, electrolyte and

9. Lawrence, K. B.: Basal Cell Epithelioma of Anus: Report of Two Cases, Arch. Surg. **43**:88-93 (July) 1941.

10. Raiford, T. S.: Epitheliomata of Lower Rectum and Anus, Surg., Gynec. & Obst. **57**:21-35 (July) 1933.

11. Keyes, E. L.: Squamous Cell Carcinoma of Anus and Rectum, S. Clin. North America **24**:1151-1161 (Oct.) 1944.

12. Kerr, J. G.: Squamous Cell Carcinoma of Anorectal Region, Texas State J. Med. **36**:548-551 (Dec.) 1940.

protein balance, the more liberal use of blood and plasma and the use of the sulfonamide drugs and penicillin in the control of infections. These factors apparently influenced the surgical treatment of cancer of the rectum throughout the country to about the same degree and at about the same time as they did at Hines Hospital. In table 4 is a résumé of the patients who were operated on elsewhere during these two periods. There were more resections performed elsewhere during the second period, and these were of the combined abdominoperineal type

TABLE 4.—*Data on Patients Operated on Elsewhere*

	Period from Jan. 1, 1931 to Jan. 1, 1940	Period from Jan. 1, 1940 to Jan. 1, 1946
Palliative colostomy	36	27
Two stage perineal excision	20	7
Combined abdominoperineal excision	4	36
Miscellaneous procedures	7	3
Total	67	73

TABLE 5.—*Data on Patients Admitted from January 1, 1931 to January 1, 1940*

	Number	Postoperative Deaths
Patients admitted	293	
No operation performed	81	
Palliative colostomy	119	21
Two stage perineal excision		
1. Second stage completed	42	4
2. Died after first stage	4	4
3. Second stage not done	8	
Combined abdominoperineal excision	17	11
Lahey operation		
1. Second stage completed	8	3
2. Died after first stage	3	3
3. Second stage not done	1	
Miscellaneous procedures		
1. Local excision	4	0
2. Fulguration and irradiation	4	0
3. Modified Mikulicz operation	1	0
4. Coffey operation	1	0

rather than the two stage perineal excisions performed during the first period.

In table 5 is a review of the data on patients admitted to the hospital from January 1931 to January 1940. Of a total of 293 patients, in only 69 was a major resection completed, a resectability rate of only 20 per cent. The mortality for the seventeen combined abdominoperineal operations (65 per cent) and the eleven two stage Lahey operations (55 per cent) was prohibitive. On the other hand, two stage perineal excisions (preliminary colostomy followed by a perineal

excision) of the Mummery type were attempted in 46 cases. Four patients died after the first stage and 4 after the second stage, a total mortality of 17 per cent. This type of operation under present conditions can probably still result in a smaller death rate than the one stage operation, but when one includes in the statistics the number of patients on whom the second stage is not performed, either because the patient refuses to undergo the operation or because his condition does not permit it, the advantage of a smaller immediate death rate is lost.

Of 411 patients admitted to the hospital from 1940 to 1946 (table 6), 199 were subjected to major resections, with 19 deaths, a resectability rate of 45.6 per cent and a death rate of 9.6 per cent. The operation of choice was the combined abdominoperineal resection of Miles; this was performed on 175 patients, with 18 deaths, a mortality of 10.6 per cent. Of this group, 9 had preliminary colostomy and 3 had

TABLE 6.—*Data on Patients Admitted from January 1, 1940 to January 1, 1946*

	Number	Postoperative Deaths
Patients admitted	411	
No operation performed	59	
Palliative colostomy	146	12
Two stage perineal excision		
1. Second stage completed	16	1
2. Second stage not done	3	
Combined abdominoperineal excision—miscellaneous procedures	175	18
1. Local excision	3	0
2. Primary anastomosis	6	0
3. Completed Lahey operation	1	0
4. Modified Mikulicz operation	1	0
5. Fulguration and irradiation	1	0

resections in the presence of metastases to the liver. Although there has been a notable increase in the percentage of patients subjected to a resection, it is doubtful that there could be a further increase of much more than 10 per cent. Hines Hospital has been a center to which all patients with tumors were sent from many other hospitals covering a large area. It must be borne in mind that no matter what the condition or the location of the patient he was admitted to Hines Hospital for therapy if he could be sent by rail or bus. Since the hospital was also a center for radiation therapy, many patients were sent for the purpose of receiving this therapy only.

In addition, because of the cost of medical and hospital care to a person who has lost all present and future earning capacity, it is the custom of many private physicians to refer patients who have an inoperable cancer or who are in the terminal stage to government institutions. The number of patients admitted in the advanced stage of the disease who were given no treatment and who died within two

months of the time of admission (10 per cent) and the number of those who refuse to undergo operation or who go elsewhere to have it performed would alone preclude the possibility of the resectability rate in our cases reaching the level of 83 per cent obtained by both Hayden [13] and Lahey.

A review of the literature will show that prior to 1941 the resectability rate varied from approximately 40 per cent to 60 per cent and the mortality rate from 10 per cent to 15 per cent when the resections were in the hands of the most experienced surgeons. The occasional operator probably had a 30 to 50 per cent mortality when resection was done in only 25 per cent of the cases. Since 1941, however, the most experienced surgeons have been reporting resectability rates of 60 to 80 per cent and mortality rates of 5 to 10 per cent. The general improvement has been so uniform that in any comparison of statistics one must consider the period during which they were collected. Thus Cattell,[14] of the Lahey Clinic, has reported 287 resections during the years 1938, 1939 and 1940, with 30 deaths, and 103 resections during 1941, with only 6 deaths. Lahey himself in 1945 reported a resectability rate of 83.5 per cent and a mortality rate of only 3.9 per cent. The present status of mortality and operability of carcinoma of the rectum in the hands of the more experienced surgeons is exemplified by the following data from the literature. In Hayden's [13] 238 cases the resectability was 83 per cent and the mortality 13 per cent, in Bacon's [15] 256 cases the resectability was 81.2 per cent and the over-all mortality 7.6 per cent and in Rankin's [16] cases the resectability was 74.8 per cent and the mortality 7 per cent. David and Gilchrist [17] performed 129 abdominoperineal resections, with a 10 per cent mortality (1942) and Fansler [18] 57 abdominoperineal resections, with a mortality of 5.25 per cent (1944). Daniel [8] reported the mortality as varying from 11 to 14.6 per cent for 196 resections of all types during the preceding eleven

13. Hayden, E. P.: The Surgical Treatment of Carcinoma of Rectum: Statistics on One Hundred and Ninety-Eight Cases of Resection, New England J. Med. **233**:81-84 (July 26) 1945.

14. Cattell, R. B.: Symposium on Surgical Management of Malignancy of Colon; Carcinoma of Colon and Rectum; Report of Five Hundred and Three Patients Treated at Lahey Clinic, 1938-1941, Inclusive, Surgery **14**:378-386 (Sept.) 1943.

15. Bacon, H. E.; Gass, O. C., and Todhunter, W. D.: Present Status of Surgical Treatment of Cancer of Rectum and Pelvic Colon, Clinics **3**:982-996 (Dec.) 1944.

16. Rankin, F. W.: Choice of Operative Methods for Carcinoma of Rectum, Surgery **7**:667-673 (May) 1940.

17. David, V. C., and Gilchrist, R. K.: Extension of Borderline of Operability in Cancer of Rectum, Ann. Surg. **115**:566-573 (April) 1942.

18. Fansler, W. A.: Carcinoma of Rectum with Report of One Hundred Consecutive Operative Cases, Minnesota Med. **27**:53-59 (Jan.) 1944.

years and as being only 4.4 per cent for the preceding five years. Besser [19] reviewed 348 cases from the University of Iowa for the years 1937 to 1944 and found an over-all operability rate of 43 per cent. From 1937 to 1941 the mortality was 31.5 per cent for 63 cases, and from 1941 to 1944 it was 10.8 per cent for 64 cases.

The mortality from resections is probably higher among males than among females. In a comparable series collected by the British Ministry of Health [20] the mortality rate among males was 18.9 per cent and among females 15 per cent. Gabriel [21] reported the mortality from perineal excision as 13.2 per cent among males and as 8.3 per cent among females. Norbury,[22] however, in a review of a large series gave an almost identical death rate of 13 per cent for the two sexes. Operability is lower for males,[23] perhaps largely because of the proximity of the prostate, but the difference is not great.

During the past ten years, as mortality rates have diminished, the majority of surgeons in this country have abandoned the two stage resection by colostomy and perineal excision for the one stage combined abdominoperineal resection. Many look on the latter as the final operation of choice. However, there is every reason to believe that the general reduction in operative mortality will permit many more procedures designed to preserve an anal sphincter. Bacon [23] has published an excellent review of sphincter preservation in operations for rectal cancer and in another article [24] has reported five years' experience with resection by the Babcock operation of abdominoperineal proctosigmoidectomy. His resectability rate was 80.4 per cent for 461 cases. Of 371 resections, 236 were of the Babcock type, with satisfactory preservation of anal continence in 80 per cent and a mortality of a little over 6 per cent. Dixon [25] has reported 340 cases in which anterior

19. Besser, E. L.; Peterson, F. R., and Dulin, J. W.: Surgical Treatment of Carcinoma of Rectum, J. Iowa M. Soc. **35**:468-471 (Dec.) 1945.

20. Report on Cancer of the Rectum, Great Britain Ministry of Health, Reports on Public Health and Medical Subjects no. 46, London, 1920-1939.

21. Gabriel, W. B.: The End-Results of Perineal Excision and of Radium in Treatment of Cancer of Rectum, Brit. J. Surg. **20**:234-248 (Oct.) 1932.

22. Norbury, L. E. C.: Carcinoma of the Rectum, London, H. K. Lewis & Co., Ltd., 1941.

23. Bacon, H. E.: Evolution of Sphincter Muscle Preservation and Reestablishment of Continuity in Operative Treatment of Rectal and Sigmoidal Cancer, Surg., Gynec. & Obst. **81**:113-127 (Aug.) 1945.

24. Bacon, H. E.: Abdominoperineal Procto-Sigmoidectomy for Cancer of Rectum: Conclusions Based on Five Years' Experience, Am. J. Surg. **71**:728-742 (June) 1946.

25. Dixon, C. F., and Lichtman, A. L.: Anterior Resection for Malignant Lesions of the Upper Part of the Rectum and the Lower Part of the Sigmoid, in Collected Papers of the Mayo Clinic, Philadelphia, W. B. Saunders Company, 1945, vol. 37, p. 100.

resection with reestablishment of intestinal continuity by end to end anastomosis was carried out, with a mortality of 5.9 per cent for the period from 1930 to 1945 and a mortality of only 1.1 per cent for the last five years of this period. The five year survival rate was 67.7 per cent. It is difficult to contemplate these figures and to believe that the combined abdominoperineal resection will continue to be so pre-eminently the operation of choice.

LIFE EXPECTANCY

The Tumor Registry of the Veterans Administration Hospital, Hines, Ill., under the direction of Dr. G. R. Allaben, has been able to follow up 98.9 per cent of all cases. The cause of death is taken from the report of the autopsy, a copy of the death certificate or a letter from the deceased person's physician. In only rare instances is the cause of death as stated by a relative considered acceptable. It is probably because of the accuracy with which the cause of death is determined that we were surprised to find that of a total of 663 patients who died with carcinoma of the rectosigmoid in only 9 was death due to causes other than the cancer. If a person has or has had cancer of the rectum and dies within ten years, it can be safely assumed that he died as a result of the cancer! If, after a resection, he lives beyond five years, his remaining life expectancy is only a little less than that of other persons in his own age group.[26] Nevertheless, when he dies it is usually from the cancer, while the remainder of the population are dying at about the same rate from cardiovascular disease or from cancer of some other structure.

In order to evaluate the effect of irradiation and colostomy on life expectancy, an analysis was made of the group of patients admitted from 1931 to 1943 (chart 3). During this period, in which there were a total of 621 persons admitted, there were 239 patients who survived a colostomy performed either at this hospital or elsewhere. The records of 12 of these patients could not be used because of lack of information as to the onset of symptoms or the time of death. There were 121 patients who were not operated on, and the records of 13 more were inadequate. Although patients admitted from 1942 to 1943 were used in a five year study of survival ending with 1945, the statistics are correct in that all patients in these categories who were admitted during the years 1942, 1941 and 1940 were dead on Jan. 1, 1946.

Natural Duration of Life.—There were 66 patients who had no treatment. The average duration of life was 14.6 months, and the

26. Dukes, C. J.: Surgical Pathology of Rectal Cancer: President's Address, Proc. Roy. Soc. Med. **37**:131-144 (Feb.) 1944.

median was ten months. One patient lived sixty-six months. Daland [27] found in a study of 100 untreated patients that the average length of life was 17.2 months and the median fourteen months. The shorter life expectancy in our series can, perhaps, be attributed to the fact that patients with less malignant tumors lived long enough to receive adequate irradiation. Lazarus-Barlow [28] studied 345 cases involving untreated patients and found a mean life expectancy of 20.4 months for men and 25.9 months for women. Wyard [29] also found a much longer natural duration—twenty-eight months for men and twenty-nine months for women. It is difficult to account for this discrepancy except on the basis of the fact that in our series we discarded the records of patients who had rectal bleeding over many years, sometimes ten or twenty

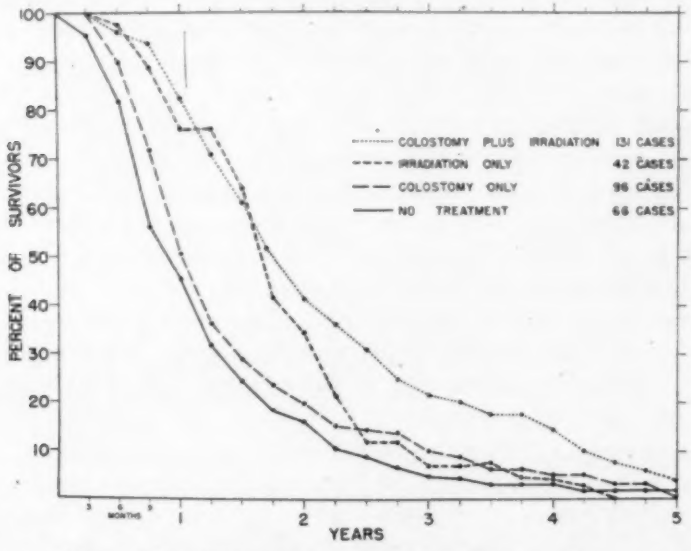

Fig. 3.—Effect of irradiation on the survival rate in carcinoma of the rectosigmoid (from onset of symptoms).

years, and of those from whose history we could not determine the time of onset of malignant change.

Duration of Life with Irradiation Only.—There were 42 patients who were subjected to adequate irradiation but not to colostomy. The average or mean duration of life from the onset of symptoms was 21.7 months, and the median was 20.2 months. One patient lived sixty-five months. During the first few years, patients were given

27. Daland, E. M.; Welch, C. E., and Nathanson, I.: One Hundred Untreated Cancers of the Rectum, New England J. Med. **214**:451-458 (March 5) 1936.

28. Lazarus-Barlow, W. and Leeming, J. H.: Natural Duration of Cancer, Brit. M. J. **2**:266-267 (Aug. 16) 1924.

29. Wyard, S.: Natural Duration of Cancer, Brit. M. J. **1**:206-207 (Jan. 31) 1925.

radiation by means of the radium bomb, radium inserted into the rectum and the insertion of radium needles into the tumor mass as well as by roentgen ray therapy. The vast majority, however, were subjected solely to roentgen ray therapy. It was administered chiefly through two portals, anterior and posterior, in doses averaging approximately 4,000 r. During the last few years, much larger doses were used, usually from 4,000 to 8,000 r. We took 2,500 units as the minimum quantity to be considered adequate. Patients receiving lesser amounts were considered to have had no irradiation.

Duration of Life After Colostomy Plus Irradiation.—There were 131 cases in which colostomy either preceded or followed by irradiation was performed. The average duration of life was twenty-seven months and the median 21.2 months. Three patients lived seventy-three, seventy-seven and eighty-five months respectively from the onset of symptoms. There was 1 patient still living at the end of nine years. The diagnosis in this instance was made by biopsy and verified at operation; the lesion was considered to be inoperable, and a palliative

TABLE 7.—*Duration of Life in Months (From Onset of Symptoms)*

Procedure	Number of Cases	Mean	Median
No treatment	66	14.6	10
Colostomy only	96	17.8	13.5
Irradiation only	42	21.7	20.2
Colostomy plus irradiation	131	27	21.2

colostomy was performed. A second patient who had a diagnosis of a malignant adenoma was living ten years after irradiation. He is not included in this group.

Duration of Life After Colostomy Only.—There were 96 patients who were subjected to colostomy only. The average duration of life was 17.8 months and the median 13.5 months. One patient lived eight years.

COMMENT

In table 7 is a résumé of the analysis. Chart 3 shows graphically the life expectancy in the four groups. Although the performance of colostomy apparently increased life expectancy slightly, it can be seen from the graph that if one were to exclude the untreated patients who died during the first three months of the disease the curves for patients with "colostomy only" and that for those with "no treatment" would be identical. Furthermore, it must be remembered that the "colostomy only" group includes only patients who survived the operation. From this analysis, one could say that although a colostomy does prolong life in the patient who has an obstructing lesion it does not prolong it much beyond that of the patient with a nonobstructing cancer. It is well

known that adequate irradiation in cancer of the rectum usually produces definite clinical improvement and not infrequently increases the degree of operability.[30] Because of its profound ineffectiveness as compared with surgical intervention, most surgeons have come to consider irradiation as absolutely ineffective. Such is not the case. As can be seen from the graph, adequate irradiation does prolong life. Malbin and Stenstrom [2] have reported a series of 104 cases in which the patients received heavy irradiation and were not operated on; the average duration of life was 27.5 months, and the median was twenty-one months. These results are almost identical with those in our series of patients who had irradiation and in whom colostomy was performed. They obtained a five year survival rate of 5 per cent. Apparent cures of carcinoma of the rectum have been reported from irradiation alone.[31] In making this analysis of cases in which irradiation was carried out, we are primarily interested in answering these two questions: Does irradiation produce enough effect on cancer of the rectum to warrant its use as a palliative procedure? Does it produce enough effect to warrant its use as a prophylactic measure postoperatively? The answer to both questions is in the affirmative.

Survival Rate Among Patients Subjected to Resection.—The survival curve for 176 patients who underwent abdominal-perineal resection is shown in chart 4. As these patients were admitted during the years 1940 to 1946 and the last follow-ups were early in 1946, it was necessary to devise a method which would take into consideration the different periods in the follow-up studies. The one month survival rate was based on all 176 patients admitted during 1940 to 1945, the one year survival rate on only 149 patients admitted from 1940 to 1945 and the two, three, four and five year rates on 123, 89, 55 and 22 patients respectively. Each point in the graph is obtained from data on a different number of patients. Therefore, the statistical error of each percentage varies, the highest error being in the five year survival rate, which is based on only 22 patients. This method enables one to construct a satisfactory survival curve for patients treated during the last six years.

The chart shows that 89.2 per cent of the patients were alive one month, 79.9 per cent one year, 70.7 per cent two years, 61.8 per cent three years and 45.5 per cent five years after the operation. Patients surviving abdominal-perineal resection for carcinoma of the rectum had approximately a 50 per cent chance of living five years.

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30. Pohle, E. A.; McAneny, J. B., and Lovell, B. K.: Radiation Therapy in Carcinoma of Rectum and Sigmoid: Experimental Study of "Danger" Dose of Roentgen Rays for Intestinal Mucosa in Dogs and Analysis of One Hundred and Ninety-Five Cases Treated in State of Wisconsin General Hospital During 1928-1938, Radiology **41**:225-232 (Sept.) 1943.

There were 58 cases before 1940 in which a two stage perineal excision was performed, with a five year survival rate of 32.1 per cent. There is little difference between the curve for perineal excisions and that for abdominoperineal resections for the first year, but after that the latter is at a higher level. Patients surviving a perineal excision had approximately a 35 per cent chance of living five years. Dukes [26] observed a five year survival rate of 44.9 per cent after perineal excision and 47.1 per cent after combined abdominoperineal resection. Norbury's [22] rate was 44 per cent for perineal excision and 60 per cent for abdominoperineal excision. Gabriel [21] observed a five year survival rate of 40 per cent after perineal excision. Nathanson and Welch [4] stated that there is indication that the prognosis is slightly better for females than for males. In the survey by the British Ministry of Health the five year survival rate following perineal excision was 30.5

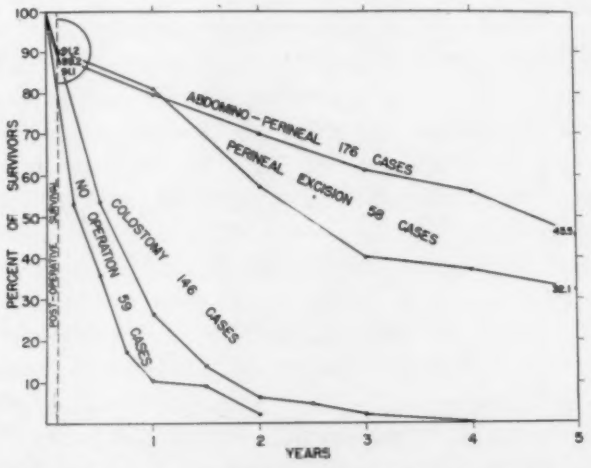

Fig. 4.—Survival rate in carcinoma of the rectosigmoid.

per cent for males and 42.6 per cent for females. Duke's figures show that the survival rate for females is the same as that for males for four years and then becomes slightly higher.

In the same chart are the survival rates for the period 1940 to 1946 for patients who had no treatment or who were subjected to colostomy but not to irradiation. The rate is calculated from the time of the patients' admission to the hospital and not from the time of the onset of symptoms.

The comparison leads to only one inescapable conclusion—a carcinoma of the rectum or rectosigmoid should be resected. The resection should be adequate if possible but should be carried out even in the most adverse circumstances.

SUMMARY

1. A statistical review has been presented of carcinoma of the rectum and rectosigmoid in 844 male patients.

2. An analysis has been made as to the character and duration of symptoms and the age distribution of the patients.

3. Resectability and mortality are reviewed.

4. Life expectancy for patients who had no treatment was compared with that for those who were subjected to irradiation only, colostomy only or colostomy plus irradiation.

5. The survival rates were calculated for patients in whom perineal excision was performed and for those subjected to the combined abdominoperineal operation.

ONE HUNDRED AND THIRTY-SEVEN CONSECUTIVE COMBINED ABDOMINOPERINEAL RESECTIONS WITHOUT MORTALITY

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CARCINOMA of the rectum and rectosigmoid is still a controversial subject in medical literature, and because of this we are presenting herein a study of one hundred and thirty-seven consecutive combined abdominoperineal resections of the rectum performed in the Cleveland Clinic Hospital from Oct. 20, 1941 to June 24, 1943 without operative mortality. We feel that this paper will contribute to the growing weight of evidence in favor of the one stage combined abdominoperineal resection as contrasted with operations of lesser magnitude. (One patient died of suppression of urine.) The technic in all cases was identical, namely, the performance of the Miles operation, with a few modifications for the operator's convenience. Spinal anesthesia with "metycaine hydrochloride" was used in every case. All wounds were closed primarily with alloy steel wire sutures. No sulfonamide drugs or antibiotics were used in the preparation of the patients or at the time of operation.

The series consisted of 93 men and 45 women, ranging in age from 24 to 75 years, the average being 54 years. The age distribution may be seen in table 1.

It is well known that there is no standard set of symptoms for carcinoma of the rectum and that a diagnosis cannot be made from the patient's history alone because of the tendency of the symptoms to mimic those in other diseases. In table 2 may be seen the symptoms most commonly observed in the group of patients studied.

Abdominal cramps were noted in 10 patients, in 9 of whom the bowel was completely obstructed.

Read at the fourth annual meeting of the Central Surgical Association, Chicago, Feb. 22, 1947.

An interesting observation was that 28 of the patients complained of hemorrhoids within a period of about six months prior to the diagnosis of malignant growth and in 75 per cent of these hemorrhoidectomy had been performed in the same period.

Anemia was neither a common nor an important complication of carcinoma of the rectum in this series. Only 18 patients (13 per cent) had anemia of any significance. Of these, 15 (11 per cent) had only moderate anemia (red cells below 3,000,000, or 40 per cent).

TABLE 1.—*Age Distribution Among Patients with Carcinoma of the Rectum*

Men	Number of Patients
24 to 30 years	3
31 to 40 years	8
41 to 50 years	31
61 to 70 years	42
71 years and over	9
Women	
30 to 39 years (aged 36 and 39)	2
40 to 49 years	12
50 to 59 years	12
60 to 69 years	18
70 to 79 years (aged 75)	1

TABLE 2.—*Symptoms Observed in Patients with Carcinoma of the Rectum*

	Cases	Percentage
Bleeding in some form	121	87
Bleeding alone	15	11
Diarrhea	51	36
Diarrhea alone	6	4
Constipation	38	27
Constipation alone	3	2
Blood, mucus and diarrhea	11	7
Blood, mucus and constipation	13	9
Diarrhea and mucus	1	0.8
Change of some type in bowel habits	106	76
Alternating constipation and diarrhea	33	24
Rectal pain	25	18
Tenesmus	17	12

Another interesting observation was that loss of weight did not commonly accompany carcinoma of the rectum until it was far advanced. Two patients in this series gained weight, 49 (35 per cent) lost from 1 to 10 pounds (0.5 to 4.5 Kg.), 37 (27 per cent) lost from 11 to 20 pounds (5 to 9 Kg.) and 13 (9 per cent) lost from 21 to 30 pounds (9.5 to 13.6 Kg.). A loss of over 30 pounds was encountered in only 6 cases.

The duration of symptoms before the diagnosis was made is of interest. As was stated by one of us [1] in a previous article, the duration

1. Jones, T. E.: Early Diagnosis and Treatment of Carcinoma of the Rectum, South. M. J. **34**:35-38 (Jan.) 1941.

of symptoms before proper diagnosis is made depends on three factors: (1) the patient's neglect in not going to a physician before the condition is in a far advanced stage; (2) disregard of good medical advice and (3) improper diagnosis of the condition in its early stages. The patients affected by the second factor are those who have been advised as to diagnosis and proper treatment but choose to disregard such advice and seek quack remedies. The patients affected by the third factor form the largest group. From an analysis of the duration of symptoms in the patients in this group it is seen that the greatest number had symptoms for nine months or longer when first interviewed (75 per cent). Only 25 per cent had symptoms from one to nine months.

It is necessary in diagnosing carcinoma of the rectum not only to take a careful history but also to make a complete physical examination, including a thorough abdominal palpation, inspection of the anus, digital examination of the rectum and sigmoidoscopic examination of the rectosigmoid and the lower part of the sigmoid colon. Because this was done, the clinical diagnosis was made correctly in 100 per cent of the cases studied at the time of the first examination. One hundred and twenty patients (87 per cent) had a palpable lesion on digital examination of the rectum. In only 18 cases (13 per cent) was a sigmoidoscopic examination required in making the diagnosis. The sigmoidoscope was used in determining the amount of circumference of the rectum involved by the lesion, the amount of fixation of the lesion, the character and type of ulceration of the mucosa and the approximate distance of the ulceration from the anorectal juncture.

Sigmoidoscopic observations on the distance of the lesion from the anorectal juncture in the group of patients studied can be briefly summarized by saying that in 100 cases (72 per cent) the lesions occurred within 10 cm., or slightly less than 4 inches, of the juncture. In 38 (30 per cent) the lesions were between 10 and 18 cm. from the juncture. In other words, all the lesions were within easy reach of the sigmoidoscope, and 70 per cent were within easy reach of the finger.

Roentgenologic study as a diagnostic procedure in carcinoma of the rectum is of little value and may be misleading because of the great difficulty in demonstrating low lying lesions. In only 3 cases of this series were the roentgenograms of the colon of diagnostic value, and in approximately 25 per cent of the cases roentgenologic study had been made before the patients were seen by us. Biopsy was carried out in only 1 case in our series. We are not of the opinion that biopsy is necessary, since the diagnosis can be made on the gross appearance of the lesion, and it may even be misleading. Often, biopsies of superficial tissue do not reveal the disease when a biopsy of tissue from deep in the tumor would.

It is not within the scope of this paper to deal with the technic of abdominoperineal resection. This was done by one of us [2] previously. Suffice it to say that the only change that has been made in the procedure since the publication of that paper is the division of the bowel between Cope clamps instead of between Payr clamps and the use of stockinet caps instead of the rubber dam tied over the cut ends of the bowel. When the abdomen is opened, the liver is first explored. The aortic glands are examined, and the fixation of the lesion itself is carefully evaluated. In 87 cases (63 per cent) the operation was performed in the standard manner, with no complicating conditions encountered. Preoperative fixation was noted in 41 cases (29 per cent), but fixation was encountered at operation in only 38, or approximately 27 per cent. In 14 of these it was necessary to remove a portion of the prostate with the rectal growth. Radium seeds were implanted into this prostatic bed or in the surrounding tissue in 6 of the 14. Nodules in the liver, undoubtedly malignant, were encountered in 9 cases. Metastatic glands were found in 4 cases. In these the operation was done mainly for comfort of the patient. In this entire series a preliminary colostomy for complete obstruction was required in only 1 instance. Incidental unrelated pathologic changes were encountered at operation in 8 cases of the group, and the performance of other operations simultaneously, that is, hysterectomy, resection of the small bowel and salpingo-oophorectomy, was necessary in only 6 cases. It has been our custom to make the colostomy opening in the midline incision at whatever point it seems to fit comfortably. In 2 cases the umbilicus was excised and the colostomy opening made at that point. In another case a McBurney operation was done on the left side because of two separate lesions, one in the rectum and the other in the sigmoid, both of which were removed. It has been customary also to trim off the excess fat and bowel from the opening on or about the tenth postoperative day and by so doing to ensure better eversion of the mucosal edges and a more satisfactory colostomy from the patient's standpoint.

The average stay of the patients in the hospital from the time of their first entrance for preparation until their discharge was 22.6 days, the maximum being fifty-three days and the minimum seventeen days. The average postoperative stay in the hospital was 18.3 days, the maximum being fifty days and the minimum twelve days.

Frequent periodic checks of the blood pressure and pulse rates were made throughout the operation. An average drop of approximately 40 mm. of mercury in the systolic pressure was noted in 129 cases. In 5 cases there were no changes and in 4 there was an actual rise in the

2. Jones, T. E.: The Technique of Abdominoperineal Resection for Cancer of the Rectum, Am. J. Surg. **27**:194-200 (Feb.) 1935.

systolic pressure. The pulse rate actually slowed in 76 cases (55 per cent). It did not change in 26 cases and increased a maximum of 20 beats per minute in 27 cases.

Before the posterior resection was done the patient was placed in the Kraske position. This position in itself is objected to by some, who are of the opinion that circulatory disturbances result. Our experience has been that most patients are not affected by the change and that some are even improved. In the entire series only 3 patients could be classed as having postoperative shock. Therefore, we concluded that while a fall in blood pressure occurred it was kept to a minimum by the use of blood and drugs and little harm resulted and that the most important indication of the patient's condition was the pulse rate. Elevations of the pulse rate during the operation were viewed with much more alarm than drops in blood pressure.

In all cases herein reported the rectosigmoid, rectum and anus were removed intact and submitted for pathologic study. Pathologic classification of the lesions may be seen in table 3.

TABLE 3.—*Pathologic Classification of Lesions*

	Cases	Percentage
Adenocarcinoma	125	90
Medullary carcinoma	5	4
Squamous cell carcinoma	4	3
Benign papilloma with malignant change	4	3

In 3 of the cases two separate malignant lesions were found in the same specimen, the lesions in 2 being an adenocarcinoma in the rectum or rectosigmoid and a squamous cell carcinoma at the anorectal juncture. Mucosal polyps separate from the malignant lesion were found in 30 cases (22 per cent). In 8 of these there were multiple mucosal polyps. Diverticula were found in 3 cases and endometriosis of the sigmoid in 2.

The average size of the lesions in the series was 29.0 sq. cm. The largest lesion was 71.25 sq. cm., and the smallest was 5.28 sq. cm. The amount of the circumference of the rectal lumen involved by the lesions varied from 10 to 100 per cent. The average amount of the circumference involved was 74 per cent. In 102 cases (74 per cent) there was no obstruction of the lumen. In 32 cases (23 per cent) there was partial obstruction of the lumen, and in 4 (3 per cent) the lumen was completely obstructed.

In the entire series the lymphatic nodes only were involved in 7 cases, or 5 per cent. The perirectal fat only was involved in 49 cases (35 per cent). The fat and nodes were both involved in 67 (40 per cent). In 15 cases there was no involvement of the fat or nodes. Table 4 illustrates the relationship between the size of the lesion and the involvement

of surrounding tissues. In 1 case we were unable to ascertain the relationship between the size of the lesion and involvement of surrounding tissue.

In the smallest lesion there was no involvement of fat but involvement of 14 per cent of the nodes. In the largest lesion of the group there was involvement of fat but no involvement of nodes. From this it can readily be seen that no definite statement can be made concerning the relationship of the size of the lesion to its spread to the surrounding structures.

We are certain that the one factor responsible for so few complications postoperatively in this series was the use of alloy steel wire sutures through all layers in closing the abdominal wound. Few ties were made with surgical gut. Most of the bleeding was stopped by pressure and hot packs. In spite of this hematomas occurred in only 3 cases. Prior to the use of steel sutures infected abdominal wounds were

TABLE 4.—*Relationship Between the Size of the Lesion and the Involvement of Surrounding Tissues*

	11 Cases	09 Cases	50 Cases	6 Cases
Area of lesion	5 to 16 sq. cm.	16 to 30 sq. cm.	31 to 50 sq. cm.	Over 51 sq. cm.
No involvement of fat or nodes	1	10	3	1
Involvement of fat alone	5	23	16	4
Involvement of nodes and fat	3	35	27	1
Involvement of nodes alone	2	1	4	0
Average percentage of nodes involved	40	20	15	33

common. Twenty-eight per cent of our patients in the era before the use of steel sutures had some type of suppuration. Without a doubt these infections of the wound were the beginning of the patient's downfall in a great many instances. The sequence would run thus: infection of the wound, peritoneal irritation, peritonitis as the infection burrowed after the suturing, poor aeration of lungs due to tender splinted abdomen, atelectasis, cough, disruption and death. With alloy steel sutures, infection rarely resulted. In this entire series infection of abdominal wounds occurred in only 3 cases (2 per cent). When infection occurred it cleared more promptly and the danger of hernia or disruption was practically nil. Other important factors in lessening complications were as follows: 1. We used no stay sutures of any type because we felt that they were uncomfortable for the patient, that their use courted infection and that they were entirely unnecessary. 2. We never stitched the serosa of the bowel to the peritoneum or the abdominal wall, as this is always a certain means of producing trouble.

Sixty-eight patients (48 per cent) had an absolutely uneventful postoperative course except for disturbances in the urinary tract, which will

be discussed later. Of the remainder, some type of mild obstruction of the small intestines or paralytic ileus developed in 13 (9 per cent). This complication first became evident from forty-eight to seventy-two hours postoperatively and was relieved successfully in all cases but 1 by the use of the Miller-Abbott tube. In that case enterostomy was required for relief.

Pulmonary complications occurred in 7 patients; 5 had atelectasis and 2 infarctions.

The posterior wound was the site of complications in only a few instances. Early postoperative hemorrhage occurred occasionally. It was generally mild, with one or two possible exceptions. Infections of the posterior wound were uncommon. They usually resulted from a pocket having been allowed to form in the depths of the wound. Four of the patients (2.8 per cent) had some type of infection of the posterior wound, in all of whom it was mild and easily taken care of.

A fistula of the posterior vaginal wall occurred in 4 cases, with a resulting delay in healing. In these cases the original lesion had been close to the vaginal wall, which had necessitated partial destruction of the wall in the removal of the growth.

The area of the colostomy was an infrequent site of complications. Necrosis of the wall down to the fascia occurred in 3 cases, with resultant leak of peritoneal fluid for several days but no other untoward results.

The most consistent and most troublesome complication was infection of the urinary tract and retention of urine. There are probably several reasons for this complication: (1) the disturbance of the innervation of the bladder by the removal of the rectum, (2) the use of a retention catheter for the first twenty-four hours postoperatively to prevent overdistention of the bladder and (3) the fact that the posterior wall of the bladder has nothing left to push against when contracting because of the removal of the rectum. This last fact is evidenced by patients who void fairly well for the first three or four days or until the posterior pack has been removed and then cease voiding entirely.

In all men of over 50 years of age we ascertained before operation that prostatic hypertrophy or obstruction to urinary outflow was not present. In spite of this only 3 patients of the group had a postoperative course uncomplicated by some type of urinary disturbance in the form of either cystitis, complete retention, large amounts of residual urine or dysuria. Therefore, it is apparent that most of the morbidity associated with the operation is due to these urinary disturbances. Usually when these disturbances were cleared up the temperatures would at once return to normal and remain so. The average patient of this group began voiding in adequate amounts nine days postoperatively. Residual urine to the amount of over 100 cc. was common for several weeks postoperatively. Complete atonicity of the bladder was encountered in 5

patients (determined cystoscopically), but all eventually demonstrated satisfactory function. Alkali-encrusted areas of cystitis, fistula of the bladder and ureteral fistula occurred in isolated instances.

In view of the controversy regarding prophylactic ligation of superficial femoral veins, particularly in old persons with malignant disease, it is likely that the proponents of this would attribute the results reported to ligation if it had been done routinely in this series. This would have necessitated two hundred and seventy-four ligations.

DISCUSSION

DR. WALTER G. MADDOCK, Chicago: Cancer is a disease that is never treated too early and seldom too radically. Yet, I am not satisfied with the opinion that all carcinomas of the rectum should be subjected to the combined abdominoperineal resection with loss of the anal sphincters. The evidence seems to be that the lymphatic metastases are almost entirely upward, being downward only in the far advanced cases in which the upward channels are entirely blocked by cancer. Anterior, posterior and lateral spread is also difficult to deal with, and as wide a resection as possible is needed in these areas. With the knowledge of the spread of carcinoma of the rectum, it seems logical that the earlier higher lesions can be resected as radically as possible and the continuity of the bowel restored by end to end anastomosis. This is being done by many surgeons in selected cases.

It has been the frequent custom in the past in patients with metastases to the liver to do the radical operation with removal of the sphincters. It is known that the length of life of these patients is relatively short. Might not the higher rectal lesions be removed and sphincter function preserved? The remaining months of life would be more nearly normal.

PERFORATED APPENDIX IN CHILDREN

IRWIN SCHULZ, M.D.
MILWAUKEE

EVEN though appendicitis is an old subject, it is still very much alive. Death occurs more frequently from this disease than from some of the spectacular operations described at this meeting. Deaths from simple acute appendicitis have become so rare that evaluation of one's methods is best studied through an analysis of cases of perforated appendix.

The following data are based on the experience of my colleagues and me with perforated appendix in children at the Milwaukee Children's Hospital. The study is limited to a consideration of children 12 years of age and under.

From 1929 through 1946 there were a total of 226 patients with perforated appendix (table 1). Twenty-six of these died. This includes

TABLE 1.—*Perforated Appendix*

1929 to 1946 inclusive	All Cases	Deaths *
Total	226	26 (11.5%)
Average age	6.4 years	4 years
Average number of days ill at admission	3.4 days	4.6 days

* Twelve deaths under thirty-six hours (all included).

all deaths, even those occurring within an hour or two after admission of the patient to the hospital.

The average age of the entire group was 6.4 years, whereas the average age of those who died was 4 years. This agrees with the common conception that the mortality rate is higher among the extremely young.

The average number of days for which the patients had been ill at the time of admission to the hospital was 3.4 days for the entire group and 4.6 days for those who died. This also agrees with the common conception that the mortality rate increases with the duration of illness at the time of admission to the hospital.

The trend in the mortality rate has been steadily downward in the course of the last eighteen years. There has beeen a rather rapid drop

Read at the fourth annual meeting of the Central Surgical Association, Chicago, Feb. 22, 1947.

since 1936, as indicated by the curve in figure 1. The lower block figures indicate the number of cases each year and the white block figures the number of deaths.

There have been only 5 patients who died in the last ten years, a mortality rate of less than 4 per cent. However, of these 5, only 1 was actually treated for perforated appendix. Three were moribund and died within twelve hours after admission to the hospital, and the other was treated for bilateral pneumonia of upper lobes. Autopsy on this patient revealed a perforated appendix in addition to the pneumonia.

In the course of these eighteen years there have been changes in therapy. The more obvious changes are wider application of nonoperative treatment and the use of sulfonamide drugs and, more recently, penicillin.

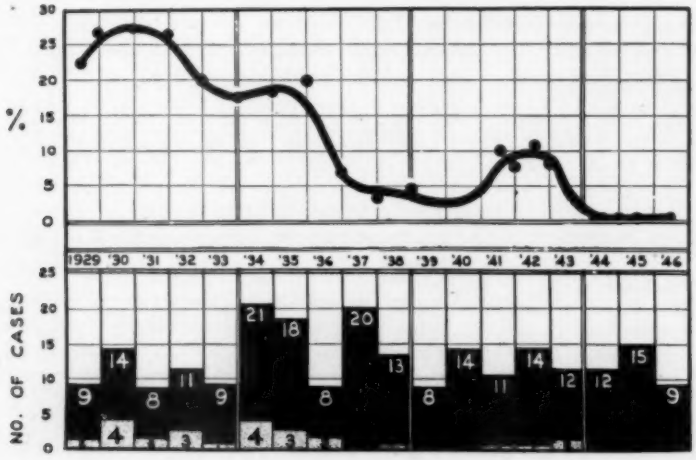

Fig. 1.—Trend in mortality rate.

These changes in therapy divided themselves, peculiarly enough, into five year periods (fig. 2).

During the first five year period (1929 to 1933) 90 per cent of the patients were operated on shortly after their admission to the hospital. The mortality rate in that period was 25 per cent.

In 1934, with the advent of Wangensteen suction, we began to apply nonoperative treatment to the group of patients in whom perforation had obviously occurred. Our experience in the following five years, when only 55 per cent were operated on at admission, revealed a drop in mortality to 12.5 per cent.

We began using sulfonamide drugs extensively in 1939. In the next five year period again only 51 per cent were operated on. The mortality rate dropped down to 6.5 per cent.

In the last three years only 33 per cent were operated on. In addition we have been using penicillin. However, for the first two years of this period less than one fourth of the patients received the drug. There have been no deaths.

In our hands the nonoperative treatment of obviously perforated appendixes in children has been extremely satisfactory. This was true before the use of sulfonamide drugs and penicillin and is contrary to the opinion often expressed in medical literature.

The duration of illness at the time of admission to the hospital is just as long (or longer) today as it was in the first five year period. This would indicate that our propaganda to get patients with acute appendicitis into the hospital early has not been successful.

It is known that the mortality rate increases with the duration of illness at the time of admission to the hospital. The dotted curve in

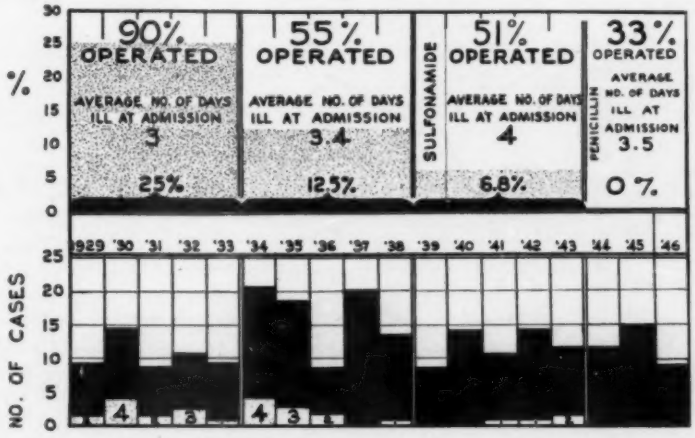

Fig. 2.—Trend in mortality rate in relation to treatment.

figure 3 is obtained from averaging data from several published reports on acute appendicitis in 1940. There is a rapid rise of mortality rate among patients ill for more than two days, which reaches a peak of 25 per cent among those ill four days at the time of admission and gradually drops off after that. In our group from 1929 to 1933 the typical curve (shown by the broken line) is exaggerated because only cases of perforated appendix are considered. There is a rapid rise in mortality rate among those ill forty-eight hours or more, which reaches a peak of 50 per cent on the fifth day and drops rapidly after that.

It is in this group, presenting the potentially highest mortality, that reduction has been obtained. This is shown by the lower curve (indicated by the solid line). There is not the expected rise in mortality rate

in those ill over forty-eight hours. In fact the mortality curve for our group of cases of perforated appendix in children from 1934 to 1946 is lower than that for cases of acute appendicitis involving patients of all ages, taken from the medical literature of 1940! It might be mentioned here that the highest mortality rate occurs among children admitted to the hospital from ten to twenty-one days after initial symptoms with a flare-up from secondary rupture of an abscess into the free abdominal cavity.

An analysis of the operative and nonoperative groups is illuminating —not for the purpose of comparing the relative merits of operative and nonoperative treatment but to determine the need for each type (table 2).

There were 87 in the nonoperative group and 85 in the operative group. The average length of illness at the time of admission to the hospital in the nonoperative group was 4.8 days; in the operative group it was 1.8 days. This would indicate that we are applying conservative

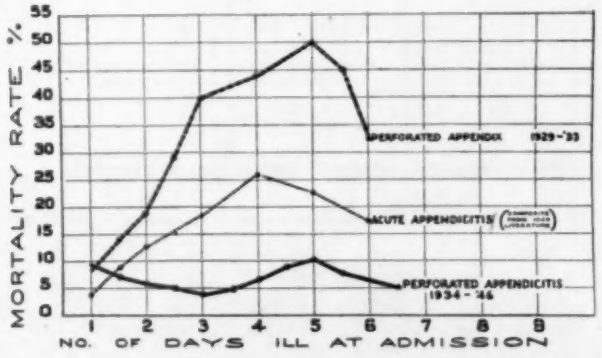

Fig. 3.—Relation of mortality to duration of symptoms.

treatment to the group with the potentially high death rate and not to the group with early disease.

The nonoperative treatment is not used as a substitute for operation. It is used only for those patients presenting imposing evidence that the appendix is already perforated. The operative group, on the other hand, includes all the early cases of perforation and many in which perforation was not even suspected.

It is known that the appendix perforates early in children. We observed 2 instances in which the appendix was found perforated within three hours and a number in which perforation had occurred within twelve hours after the onset of symptoms.

The appendix was not removed in 18 of the patients operated on when admitted to the hospital. In the presence of frank peritonitis

from a perforated appendix we do not hesitate to leave it in if it is not readily removable. It is then removed two to three months later.

The question may arise as to how one can be certain that the patients in the nonoperative group really had appendicitis. Analysis of the hospital records reveals that in 96 per cent a palpable abscess developed during the course of illness. Only 12 per cent of these required late drainage of the abscess. In the remaining 67 cases the abscess either ruptured spontaneously into the bowel or was absorbed. Fifty-seven of the nonoperative group came to the hospital for appendectomy at a later date. In all these the operation revealed unequivocal evidence of previous perforation and peritonitis.

From a statistical analysis such as this, one could be carried away by enthusiasm for nonoperative treatment or for the use of sulfonamide drugs and penicillin.

TABLE 2.—*Perforated Appendix*

	Nonoperative	Operative
Cases	87	85
Number of days ill at time of admission	4.7 days	1.8 days
Average age of patient	6 years	6.6 years
Number of days in hospital	29.1 days	25 days
Number of days temperature was down	9 days	9.3 days
Abscess palpable	84 (97%)	
Drained late in course of treatment	10 (12%)	
Appendix removed at later admission	58	
Drainage only at operation	.....	18 (21%)
Number of deaths *	3 (3.4%)	4 (4.7%)

* Deaths under thirty-six hours not included.

However, the progressive drop in mortality rate should not be attributed to these changes in therapy alone. It is our impression that the most important but less spectacular factors in this reduction have been (1) decompression of the intestinal tract by Wangensteen suction to control and prevent distention, (2) a better knowledge of electrolyte and fluid balance, and (3) the wider use of blood transfusion (which is almost routine). Time does not permit further discussion of these points.

As far as surgical technic is concerned, there has been no change. The split muscle type of incision has been used since before 1923. We cannot draw any definite conclusions from our experience regarding the relative merits of drainage versus nondrainage in the patients operated on. After using nondrainage in a large group of children during the last eight to ten years, I have become less and less enthusiastic about it. I

have never been sorry when a drain has been inserted but have been sorry several times when drainage was not used.

CONCLUSIONS

Based on our experience with perforated appendix at the Milwaukee Children's Hospital, the following conclusions may be drawn:

1. There has been a steady reduction in the mortality rate since 1936.

2. This reduction has been obtained in the group who are critically ill, i. e., those who have been ill forty-eight hours or more.

3. Important factors in reduction have been the use of Wangensteen decompression, proper fluid and electrolyte balance, multiple small transfusions of whole blood, nonoperative treatment of the group in whom perforation has obviously occurred and the use of antibiotics (sulfonamide drugs and penicillin).

Notices

ESTABLISHMENT OF A NEW DEPARTMENT

The editors of the ARCHIVES have decided to establish a section of this journal to be entitled "The Surgical Clinic." At appropriate intervals, perhaps monthly, the verbatim report of a discussion of a case as conducted by members of some surgical staff will be published. In addition to routine history, physical findings, laboratory and roentgen ray reports, the proceedings will include the above-mentioned unrehearsed discussion and a note on the operative findings, with the pathologic report if subsequently available. The presentation will conclude with a brief summary or analysis of important points by the chief of the clinic or other presiding officer. It is anticipated that such a presentation will occupy four to eight pages in the ARCHIVES, including illustrations. This section will be supervised by Dr. Gustaf E. Lindskog, of the editorial board.

Another innovation will be a section called "The Surgical Forum," to be conducted by Dr. Robert Elman, of the editorial board. In it will be published (*a*) queries in regard to surgical problems, (*b*) unusual surgical experiences and (*c*) subjects for discussion about which the readers desire additional information. These should be addressed to the Archives of Surgery, 535 N. Dearborn St., Chicago, and they will then be distributed to various editors, whose response will be published with the queries. All communications will be treated anonymously. The editors hope that these features will prove of great value as a method of postgraduate teaching for surgeons and for surgical residents.

The executive officers of the Western Surgical and of the Central Surgical associations, with the approval of the fellows in these associations at the 1946 meeting of the former and the 1947 meeting of the latter, decided to submit the papers presented before these bodies to the editors of the ARCHIVES OF SURGERY for consideration. The excellence of these papers made them readily acceptable, and most of them were published during 1947; the remainder will appear in early 1948 issues. A somewhat similar arrangement has existed for several years between the editors of the *Annals of Surgery* and the officers and fellows of the American Surgical Association and the Southern Surgical Association as well as between the editors of *Surgery, Gynecology and Obstetrics* and the American College of Surgeons.

Finally, the editors wish to call attention to the fact that the ARCHIVES OF SURGERY was established at the request of a group of American surgeons at a time when these surgeons and others were experiencing difficulty in having their papers dealing with clinical and experimental investigations published in the few journals of the time. Papers dealing with these types of investigations are now eagerly sought by editors of all surgical journals. The editors of the ARCHIVES will continue to maintain the high standards of requirements for the acceptance of papers, for in doing so they try to represent the entire body of American surgeons whose surgical journal, in reality, the ARCHIVES is.